NEVADA DIVISION OF ENVIRONMENTAL PROTECTION

ANALYSIS OF A STRATOSPHERIC INTRUSION AS AN EXCEPTIONAL EVENT AND ITS CONTRIBUTION TO HIGH OZONE CONCENTRATIONS AT GREAT BASIN NATIONAL PARK, NEVADA

FINAL Report
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

1-PVU	One potential vorticity unit
° F	degrees Fahrenheit
° N	degrees North
° W	degrees West
agl	above ground level
AIRS	Atmospheric Infrared Sounder
amsl	above mean sea level
AQI	Air Quality Index
AQS	Air Quality System
ARS	Air Resource Specialists
BAQP	Bureau of Air Quality Planning
BLM-WSO	Bureau of Land Management Wyoming State Office
CASTNET	Clean Air Status and Trends Network
CFR	Code of Federal Regulations
CO	carbon monoxide
EER	Exceptional Event Rule
EPA	United States Environmental Protection Agency
GBNP	Great Basin National Park
GOES	Geostationary Operational Environmental Satellite
FRM	Federal Reference Method
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory
IPV	Isentropic Potential Vorticity
km	kilometer
m	meters
mb	millibars
NAAQS	National Ambient Air Quality Standards
NAM	North American Mesoscale
NDEP	Nevada Division of Environmental Protection
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	oxides of nitrogen
NPS	National Park Service
O_3	ozone
ppb	parts per billion
PST	Pacific Standard Time
RAOB	Radiosonde Observations
RAQMS	Realtime Air Quality Monitoring System
RH	relative humidity
SI	Stratospheric Intrusion
U.S.	United States
UTC	Coordinated Universal Time
VOCs	volatile organic compounds

ANALYSIS OF STRATOSPHERIC INTRUSION AS AN EXCEPTIONAL EVENT AND ITS CONTRIBUTION TO HIGH OZONE CONCENTRATIONS AT THE GREAT BASIN NATIONAL PARK CASTNET SITE ON JUNE 8, 2015

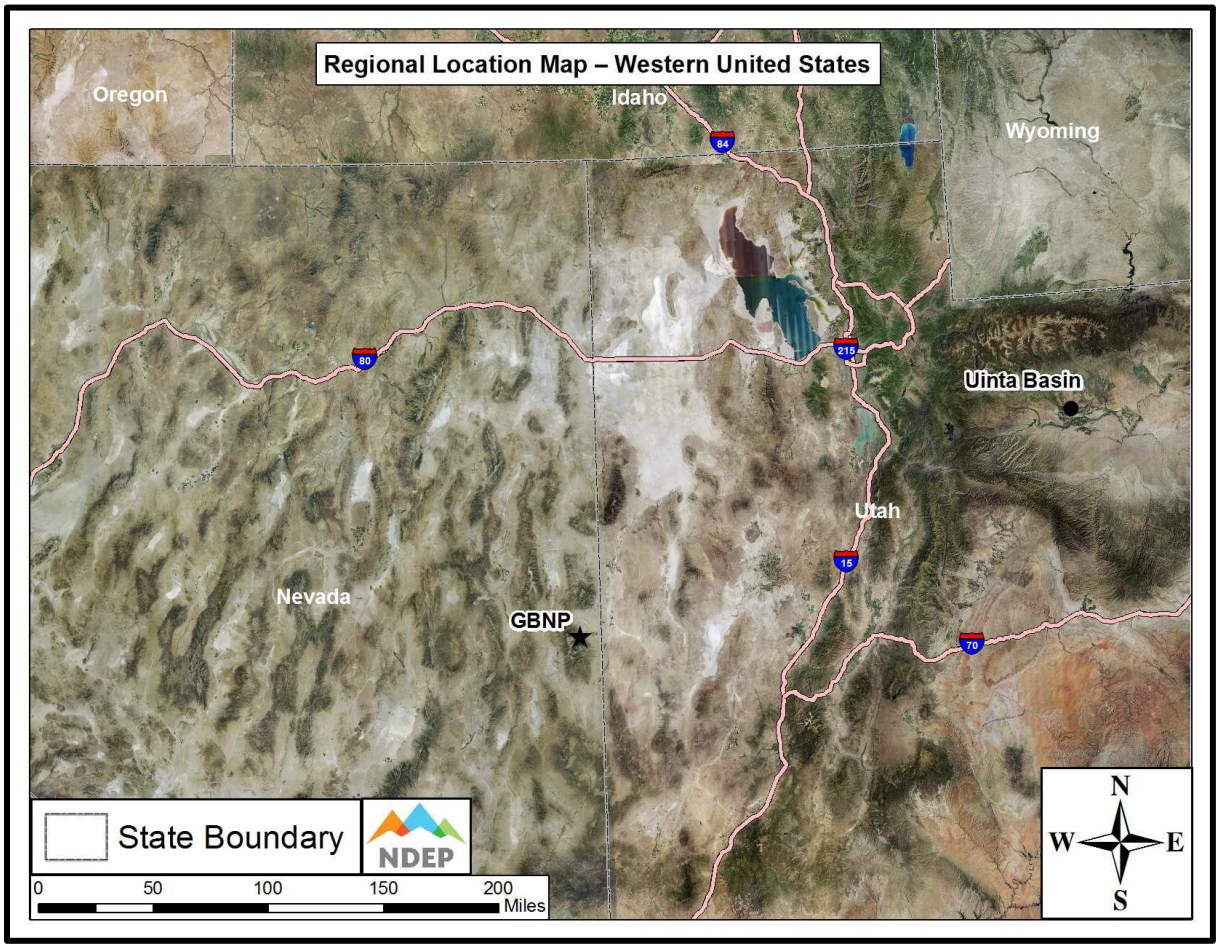
1.0 INTRODUCTION

The Nevada Division of Environmental Protection (NDEP) Bureau of Air Quality Planning (BAQP) operates a network of ambient air quality monitors at a variety of locations throughout the state of Nevada. In addition to this regulatory network, the NDEP is responsible for the quality and integrity of the ozone data collected at the National Park Service air monitoring site at Great Basin National Park (GBNP), which is part of the Clean Air Status and Trends Network (CASTNET) (Figure 1). CASTNET is a long-term monitoring network designed to measure acidic pollutants and ambient ozone concentrations in rural areas. CASTNET is managed collaboratively by the United States Environmental Protection Agency (EPA) – Clean Air Markets Division, the National Park Service – Air Resources Division (NPS), and the Bureau of Land Management – Wyoming State Office (BLM-WSO). In addition to EPA, NPS, and BLM-WSO, numerous other participants provide network support including tribes, other federal agencies, States, private land owners, and universities. The EPA contractor, Amec Foster Wheeler, operates the EPA-sponsored sites while the NPS and BLM-WSO contractor, Air Resource Specialists, Inc. (ARS), operates the remaining sites.

The GBNP CASTNET site collects ambient ozone data, reported as an hourly average, using a continuous analyzer. This site meets the siting criteria specified within 40 Code of Federal Regulations (CFR) Part 58 Appendices D and E. Additional information regarding detailed siting criteria, monitoring objectives, site types, and other relevant parameters for each monitoring site per the requirements of 40 CFR Part 58.10(b) may be found in the 2016 CASTNET Annual Network Plan.

The NDEP BAQP's ambient air monitoring network meets the minimum monitoring requirements for all criteria pollutants pursuant to 40 CFR 58, Appendix D. The NDEP BAQP's monitoring network is reviewed annually pursuant to 40 CFR 58.10 to ensure that the network meets the monitoring objectives defined in 40 CFR 58, Appendix D. The approval letter for the NDEP BAQP Annual Network Plan is included in Appendix A. Ambient air monitoring data is collected and data quality is assured in accordance with 40 CFR 58. This data is submitted to the EPA's Air Quality System (AQS). The data for 2015 was certified in April 2015. The Data Certification Letter was submitted to EPA Region IX in April 2015 as well. The Data Certification Letter is included in Appendix B.

Figure 1. Regional Location Map Showing Great Basin National Park CASTNET Site in Nevada and the Uinta Basin in Utah.



1.1 PURPOSE

On June 8, 2015, a stratospheric intrusion (SI) caused exceedances of the 70 parts per billion (ppb) of ozone (O_3) 8-hour National Ambient Air Quality Standard (NAAQS) at the GBNP CASTNET ozone monitoring location in eastern Nevada.

The NDEP is requesting exclusion of the O_3 data from the Great Basin CASTNET air monitoring site that exceeded the NAAQS as an exceptional event under the EPA's regulation for *The Treatment of Data Influenced by Exceptional Events;* (81 FR 68216; U.S. EPA, 2015a, known as the Exceptional Events Rule (EER; 40 CFR Parts 50 and 51).. The purpose of this report is to provide documentation in support of this request. The SI was a natural event that caused an exceedance of the federal standard for the Federal Equivalence Method O_3 monitor at Great Basin National Park on June 8, 2015. The 8-hour average concentration was 72 ppb on June 8, 2015 at the Great Basin monitoring site (AQS Site Code 32-033-0101). This document demonstrates that the 8-hour ozone exceedance on June 8, 2015 at the Great Basin CASTNET monitoring site meets the requirements for having been influenced by an exceptional event as

stipulated in the EER. Table 1 lists the 8-hour ozone concentration at Great Basin that is included in this request.

Table 1. Eight-hour Federal Ozone Exceedance Value at the Great Basin National Park CASTNET Monitoring Site

Monitoring Site	AQS Number	Date of Exceedance	Maximum Daily 8-hour Average O_3 Concentration (ppb)
Great Basin CASTNET	32-033-0101	06/08/2015	72

The elevated ozone concentrations observed on June 8 2015 occurred as a result of an SI event. ARS has submitted the hourly ozone data from the affected monitor on those days to the EPA AQS database on behalf of the NPS. At the request of NDEP, ARS has also associated the appropriate AQS flags with the data to indicate that the data was affected by an exceptional event due to stratospheric intrusion. This flagging indicates that the ambient air quality data was influenced by the SI and ensures that the data is properly represented in the regulatory process.

1.2 EXCEPTIONAL EVENT DEFINITION AND DEMONSTRATION CRITERIA

The EER defines an exceptional event in 40 CFR Part 50 as an event that affects air quality, is not reasonably controllable or preventable, and is an event caused by human activity that is unlikely to recur at a particular location or is a natural event.

The following analysis will address this definition and provide documentation to establish that the 2015 SI event met the criteria as set forth in 40 CFR Part 50. Specifically, this document provides evidence that the SI affected air quality by demonstrating that:

1. there was a clear causal relationship between the 8-hour ozone concentrations at Great Basin and the event;
2. the ozone concentrations during the event were above normal historical concentrations, and;
3. the 8-hour ozone concentrations at Great Basin would not have exceeded the standard without the emissions contributed by the stratospheric intrusion.

In addition, documentation is provided demonstrating that the SI was a natural event that was not reasonably controllable or preventable. This analysis includes monitoring data, meteorological data, and historical data. Finally, information regarding reasonable and appropriate actions taken to protect public health is included as Appendix C. The NDEP BAQP concludes that without the influence of the stratospheric intrusion, the measured concentrations at the Great Basin monitoring site would not have exceeded the NAAQS.

2.0 BACKGROUND

2.1 GROUND-LEVEL OZONE FORMATION

Ozone is a gas composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground level is created by a chemical reaction between oxides of nitrogen (NO_x) [including nitrogen dioxide (NO_2)] and volatile organic compounds (VOCs) in the presence of sunlight. Ozone has the same chemical structure whether it occurs miles above the earth or at ground level and can be "good" or "bad," depending on its location in the atmosphere. Specifically, NO_2 decomposes as a result of exposure to ultraviolet light from the sun to produce nitric oxide and an oxygen atom, which then combines with molecular oxygen to produce ozone. Calm winds allow O_3 precursors (NO_x and VOCs) to accumulate in order to produce O_3. Unlike ozone of stratospheric origin, ground-based ozone typically forms during the daylight hours under stagnant weather conditions (over several days in some cases) and usually dissipates a few hours after sunset.

2.2 ATMOSPHERIC STRUCTURE

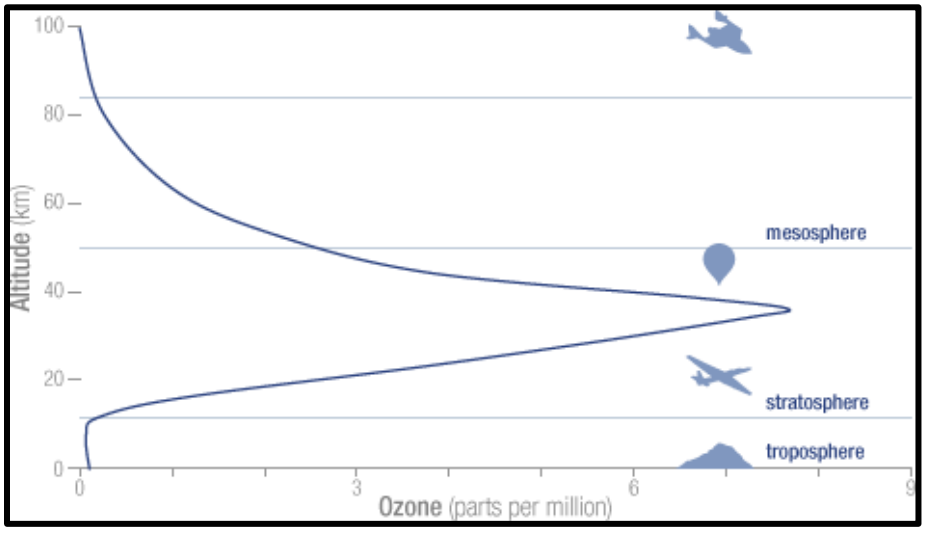
The troposphere is the layer of air adjacent to the earth's surface that contains our weather (i.e. wind, rain, snow, thunderstorms, etc.). The troposphere also contains variable amounts of water vapor and carbon monoxide (CO), extends to a height of roughly 11 kilometers (km; 6.8 miles) above mean sea level (amsl), and varies in depth from the earth's polar regions to the equator. Directly above the troposphere, the stratosphere exists with the tropopause separating the stratosphere from the troposphere. The tropopause is "...usually characterized by an abrupt change of lapse rate" (American Meteorological Society, 2010).

The stratosphere is the "...region of the atmosphere extending from the top of the troposphere [the tropopause], at heights of roughly 10-17 km...[and] is characterized by constant or increasing temperatures with increasing height and marked vertical stability" (American Meteorological Society, 2010).

2.3 COMPOSITION OF STRATOSPHERIC AIR

"While the major constituents of the stratosphere are molecular nitrogen and oxygen, just as in the troposphere, the stratosphere contains a number of minor chemical species that result from photochemical reactions in the intense ultraviolet radiation environment. Chief among these is ozone..." (American Meteorological Society, 2010). While the troposphere contains variable amounts of O_3, CO, and water vapor, the stratosphere lacks CO and water vapor (Pan, et al. 2004; Newell, et al. 1999; Stoller, et al. 1999). Figure 2 shows the typical concentration of ozone as a function of altitude, extending from the earth's surface through the stratosphere.

Figure 2 Vertical Profile of Ozone



http://ozonewatch.gsfc.nasa.gov/facts/SH.html

2.4 STRATOSPHERIC INTRUSIONS, TROPOSPHERIC FOLDING, AND IDENTIFYING STRATOSPHERIC AIR

Weather producing systems (i.e. tropospheric storm systems, upper level disturbances or upper level storm systems) contain atmospheric spin or vorticity, which induces vertical motion: either upward or downward. From late winter to late spring in the northern hemisphere, vertical motion associated with upper level disturbances aids in causing the tropopause to "fold" or descend into the troposphere where our weather occurs (Danielsen, 1968). Because of tropopause folding, an intrusion of stratospheric air containing high concentrations of ozone penetrates into the troposphere (Reed, 1955) releasing ozone-rich air from the stratosphere to the troposphere. As a result, the SI creates the potential for ground level ozone monitors over the higher terrain of the western United States to experience elevated ozone readings.

SIs are a tangible phenomenon. One study analyzed over 105,000 aircraft soundings, and discovered that just over 50 percent of the soundings contained regions of high ozone and low water vapor content occurring below the tropopause (Newell, et al., 1999). The presence of areas of high ozone concentrations and low water vapor located below the tropopause are signatures of an SI.

While the concentrations of O_3, CO, and relative humidity (RH) aid the identification of air of stratospheric origin, isentropic potential vorticity (IPV) can be used as well. IPV is a proxy for atmospheric spin and is a conservative property with values of up to two orders of magnitude greater for stratospheric air than that of tropospheric air (Shapiro, 1980). Therefore, IPV can serve as an indication of stratospheric air. One unit of IPV (1-PVU) typically represents the tropopause (Shapiro, 1980), and the value of IPV increases with increasing altitude through the tropopause and stratosphere. However, within the last decade a study by Pan revealed that using

only IPV to define the tropopause is problematic. In fact, the thermal tropopause height "...spans a broad range of..." IPV values and varies latitudinally and seasonally (Pan, 2004). IPV is very useful in the identification of stratospheric air, and is best when used in conjunction with other parameters.

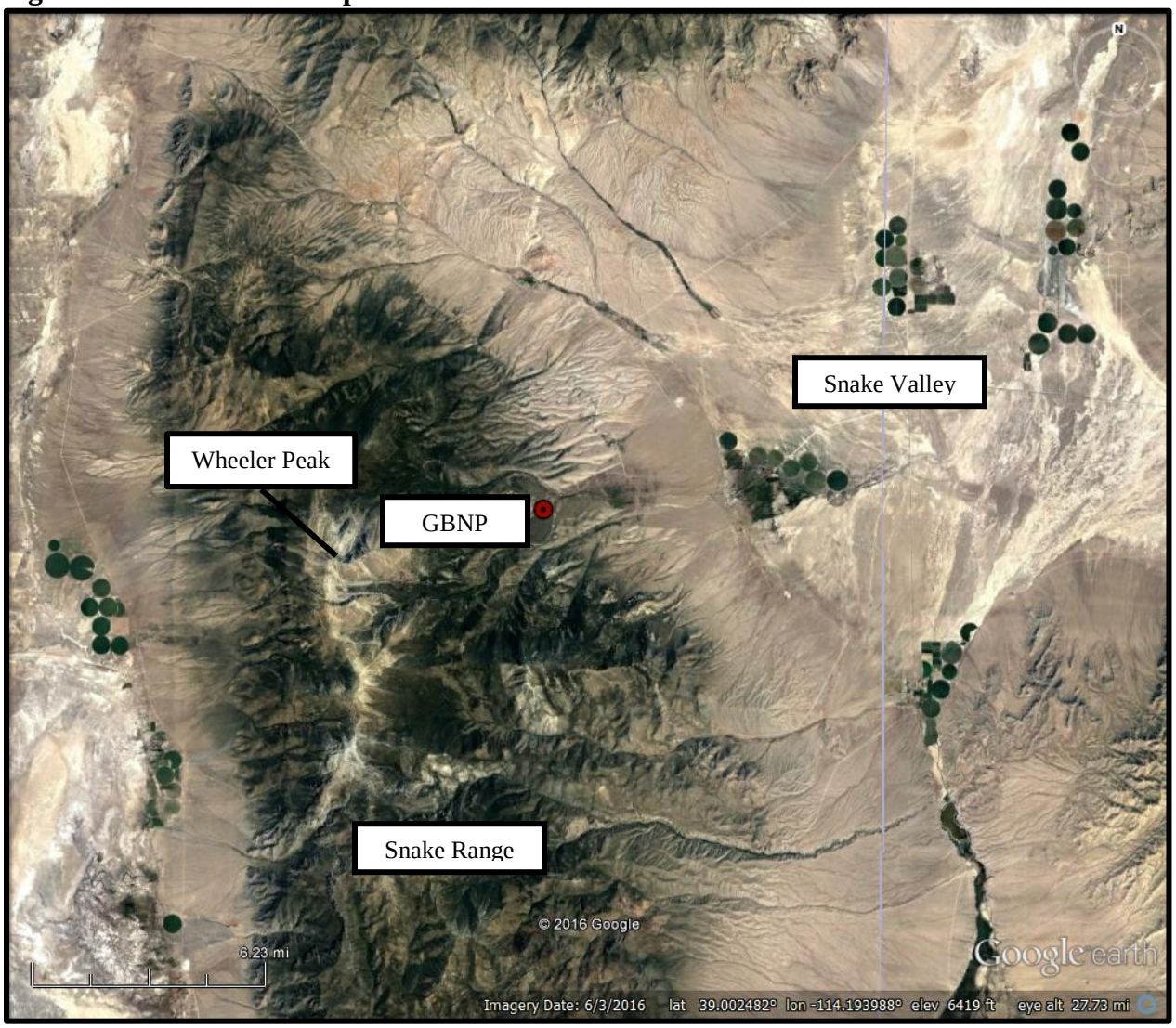
In summary, the stratosphere contains high concentrations of ozone compared to the troposphere. At times, from late winter through late spring in the northern hemisphere, tropospheric storm systems act synergistically with tropopause folds to inject stratospheric ozone into the troposphere via an SI. Compared to tropospheric air, stratospheric air is typically much drier, has higher values of IPV and contains lower amounts of CO.

Data from research aircraft have determined that tropopause folds (SIs) contain ample O_3, dry air, and low concentrations of CO. Mathematical calculations based on the aircraft data also verify that IPV values for SIs are greater than 1-PVU.

3.0 PHYSIOGRAPHIC SETTING AND CONCEPTUAL MODEL

Great Basin National Park is located in White Pine County in eastern Nevada, near the border between Nevada and Utah. The monitoring site is at approximately 6,770 feet amsl, on the eastern slopes of the Snake Range. Wheeler Peak, at just over 13,000 feet amsl, is approximately five miles west of the site. Snake Valley lies to the east, with a minimum elevation of 4,850 feet amsl (Figure 3).

Figure 3. Location Map of Great Basin National Park



Great Basin National Park is in the high desert, with typical warm summers and cold winters. The average high temperatures range from 86 degrees Fahrenheit (°F) in July to 41 °F in January. Average low temperatures range from 57 °F in July to 18 °F in January. The average annual precipitation at the park is approximately 13 inches, spread relatively evenly throughout the year. Summer thunderstorms are not uncommon in July and August, and occasionally occur

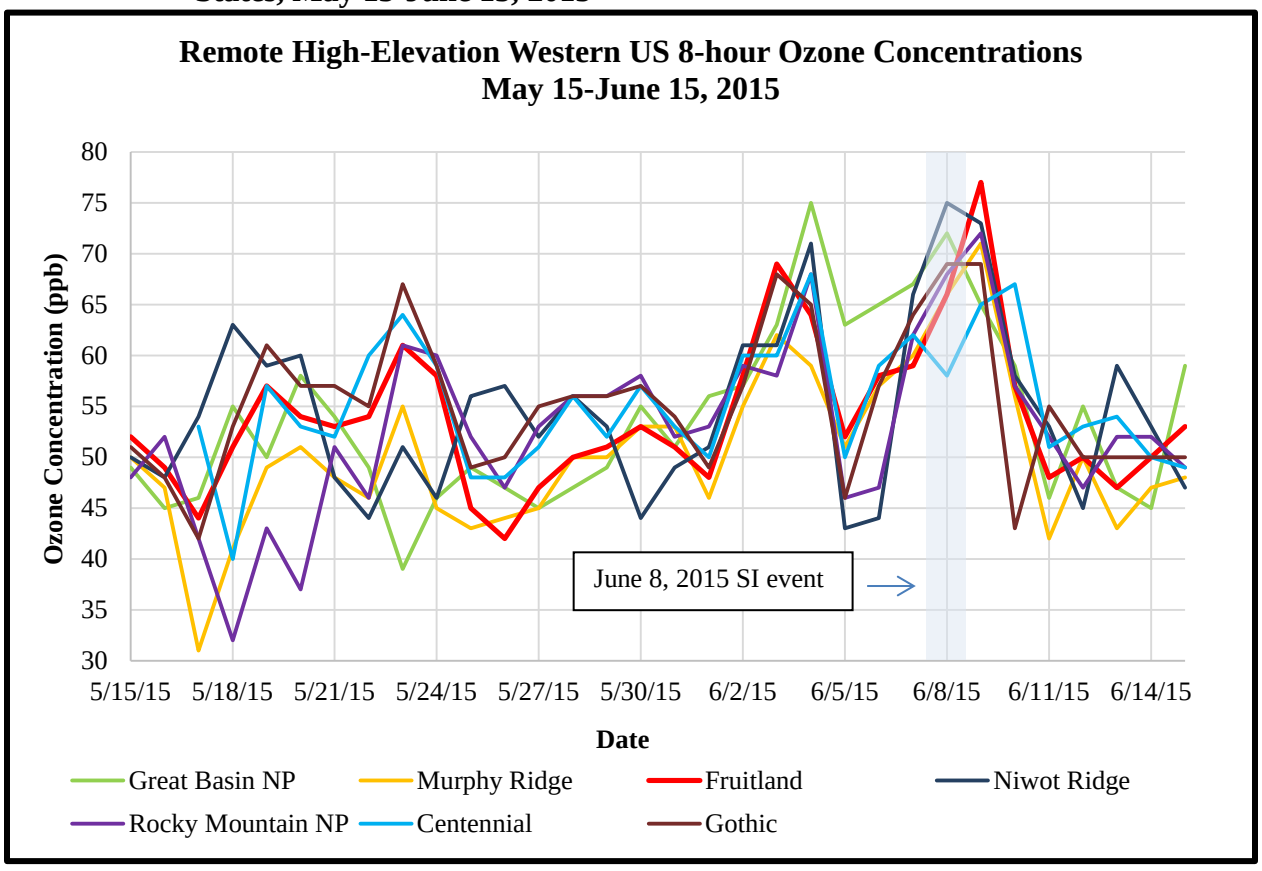
in May and June as well. Typical of the western United States, the ozone season at Great Basin National Park is April through October, with the highest concentrations usually observed in May and June.

4.0 CLEAR CAUSAL RELATIONSHIP

4.1 OVERVIEW OF THE EVENT

In early June 2015, relatively high levels of ozone were observed at remote, rural high elevation ozone monitors in eastern Nevada, Utah, and Colorado due to an SI event (Figure 4). Ozone concentrations at these sites were relatively low (less than 60 ppb) during the last week of May through June 1. The Great Basin National Park monitor recorded 8-hour ozone greater than 60 ppb each day from June 3 through 9, 2015. Other high elevation monitors were generally above 60 ppb on June 3 and 4, and on June 7, 8, and 9 (Figure 4). On June 8, 2015 the Great Basin National Park CASTNET monitor in eastern Nevada recorded an 8-hour average ozone concentration of 72 ppb, exceeding the federal ozone NAAQS. Four ozone monitoring sites managed by the Ute Indian Tribe of the Uinta and Ouray Reservation also exceeded the federal ozone NAAQS on June 8 and 9, 2015. These four sites are located in the Uinta Basin in northeastern Utah.

Figure 4. Ozone Concentrations at Remote High-Elevation Sites in the Western United States, May 15-June 15, 2015

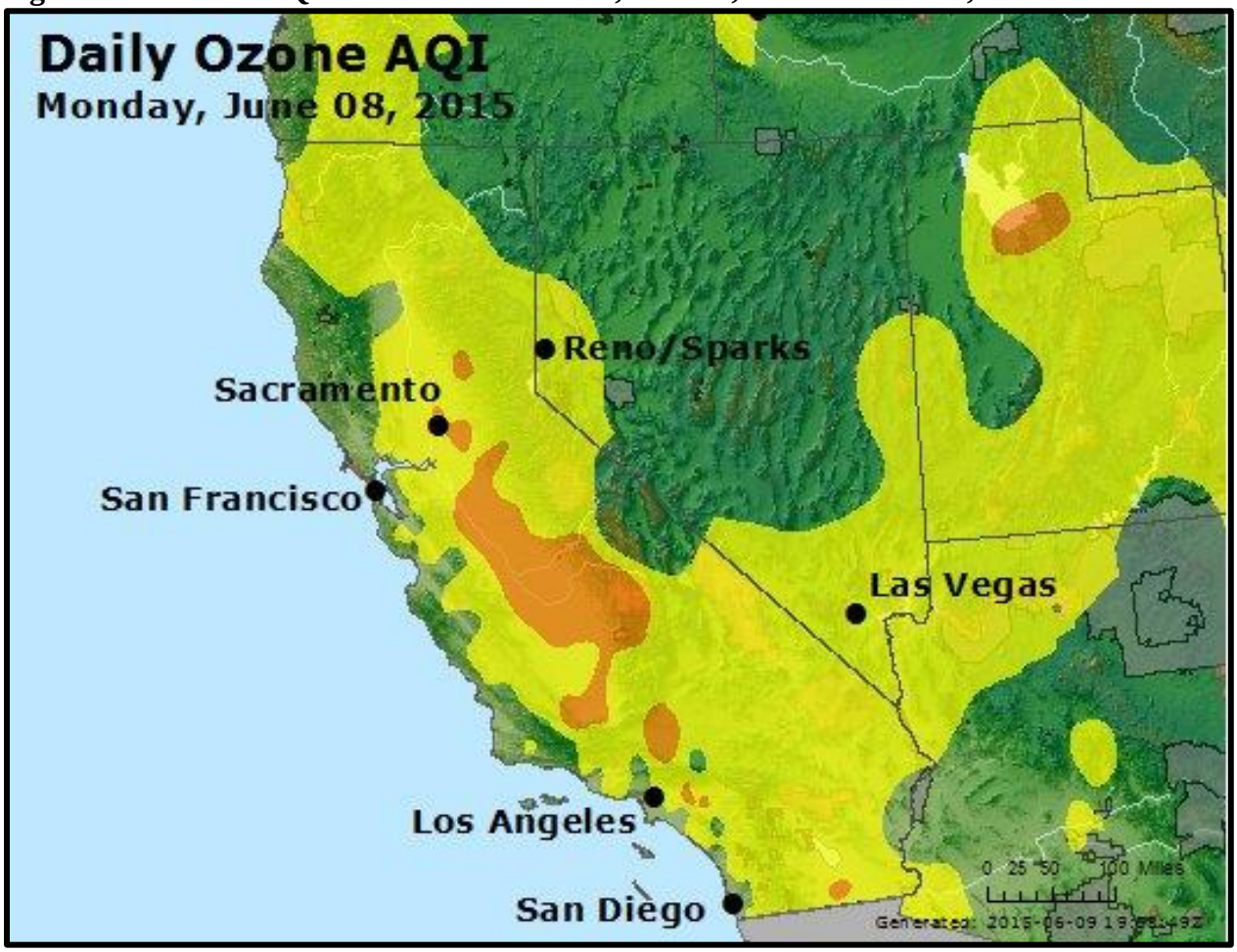


(Ute Tribe, 2016)

The EPA June 8, 2015 daily peak ozone air quality index (AQI) map illustrates the effects of the SI over eastern Nevada and Utah (Figure 5). Eastern Nevada and central Utah were either in the

"moderate" category (yellow) or "unhealthy for sensitive groups" category (orange). AQI values for June 1 through June 10, 2015 are provided in Appendix C.

Figure 5. Peak AQI Values for California, Nevada, and Utah June 8, 2015



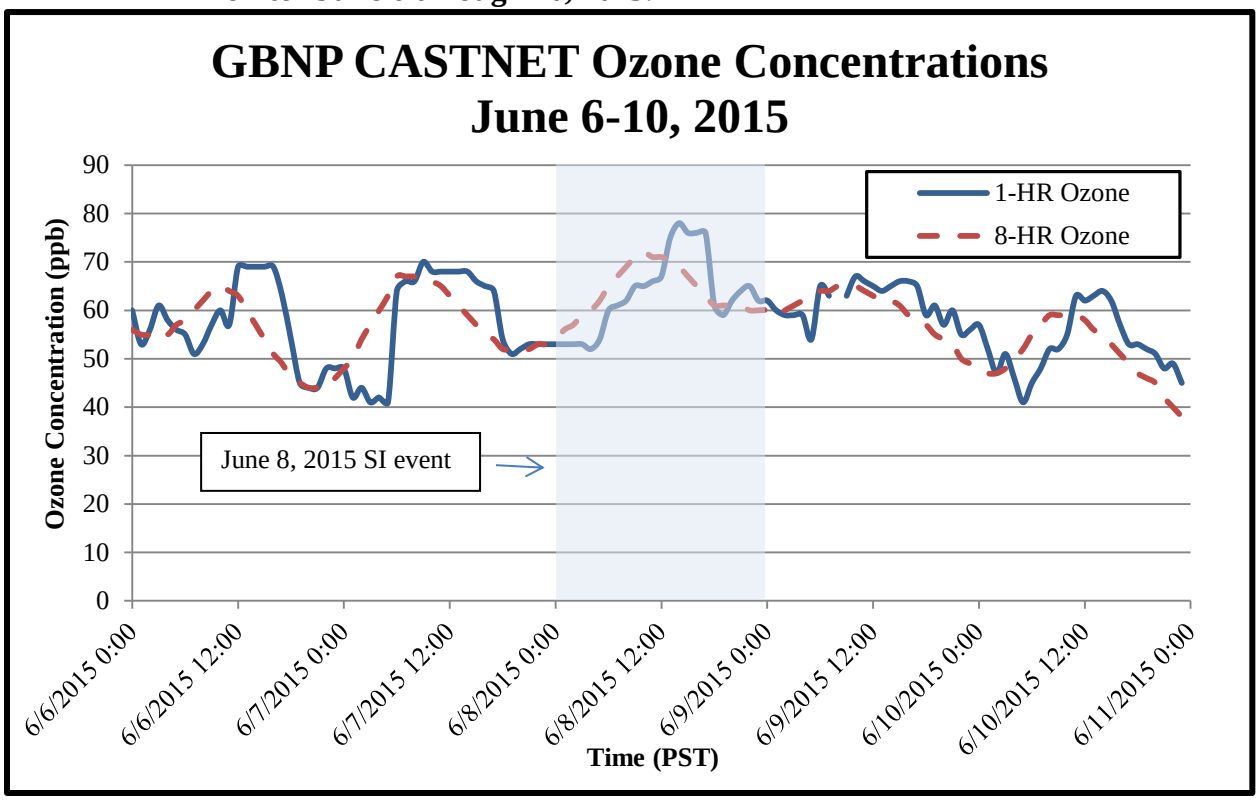
Source: https://www.airnow.gov

Accumulation of surface-based ozone precursors did not occur because meteorological conditions were not supportive of precursor buildup prior to elevated ozone readings. In addition, due to the rural location of GBNP, there are no local sources of ozone precursors.

For the month of June from 2011 to 2015, ground-level, 8-hour average ozone concentrations at the GBNP CASTNET ozone monitor ranged from 52-64 ppb (25-75% interquartile range) with a median of 59 ppb. When an SI occurs, 8-hour average values (derived from the 1-hour average) can exceed 80 ppb on a time scale of a few hours to a few days (Mohnen and Reiter, 1977). While not exceeding 80 ppb, 8-hour average ozone concentrations greater than 70 ppb occurred for four consecutive hours at the GBNP ozone monitoring site on June 8, 2015. At 2200 coordinated universal time (UTC) on June 8, 2015, the GBNP ozone monitor recorded a 1-hour

average ozone value of 78 ppb resulting in a daily maximum rolling 8-hour average of 72 ppb (Figure 6).

Figure 6. One-hour and 8-hour Ozone Concentrations for the GBNP CASTNET Monitor June 6 through 10, 2015.



4.2 DATA QA/QC AND EQUIPMENT

Quality Assurance/Quality Control procedures for the GBNP CASTNET ozone monitoring site were followed in accordance with 40 CFR Part 58, Appendix A, Section 3.2 *Measurement Quality Checks of Automated Methods* and the *Quality Assurance Project Plan*.

During second quarter of 2015, ARS conducted an independent performance audit of the ozone analyzers at GBNP (Appendix D). All tests met NDEP specified data quality objectives, which are consistent with QA Handbook Vol II, Section 3.0, Revision No: 1.

4.3 STATISTICAL ANALYSIS AND COMPARISON TO HISTORICAL DATA

The distribution of daily maximum 8-hour ozone values for the GBNP ozone monitor for the month of June from 2011-2015 is shown in Figure 7. The June 8, 2015 GBNP daily maximum 8-hour ozone concentrations (in red) are greater than the 90th percentile concentration value when compared to all June data from GBNP between 2011 and 2015. The daily maximum 8-hour ozone data for GBNP on June 8, 2015 are considerably higher than the rest of the data. There are only eight 8-hour values larger than those recorded on June 8, 2015. The NDEP is

currently investigating those exceedances, but given the very remote location of the site, stratospheric intrusion or long-range transport are likely the causes.

Figure 7. Histogram of June GBNP Ozone Data 2011 through 2015

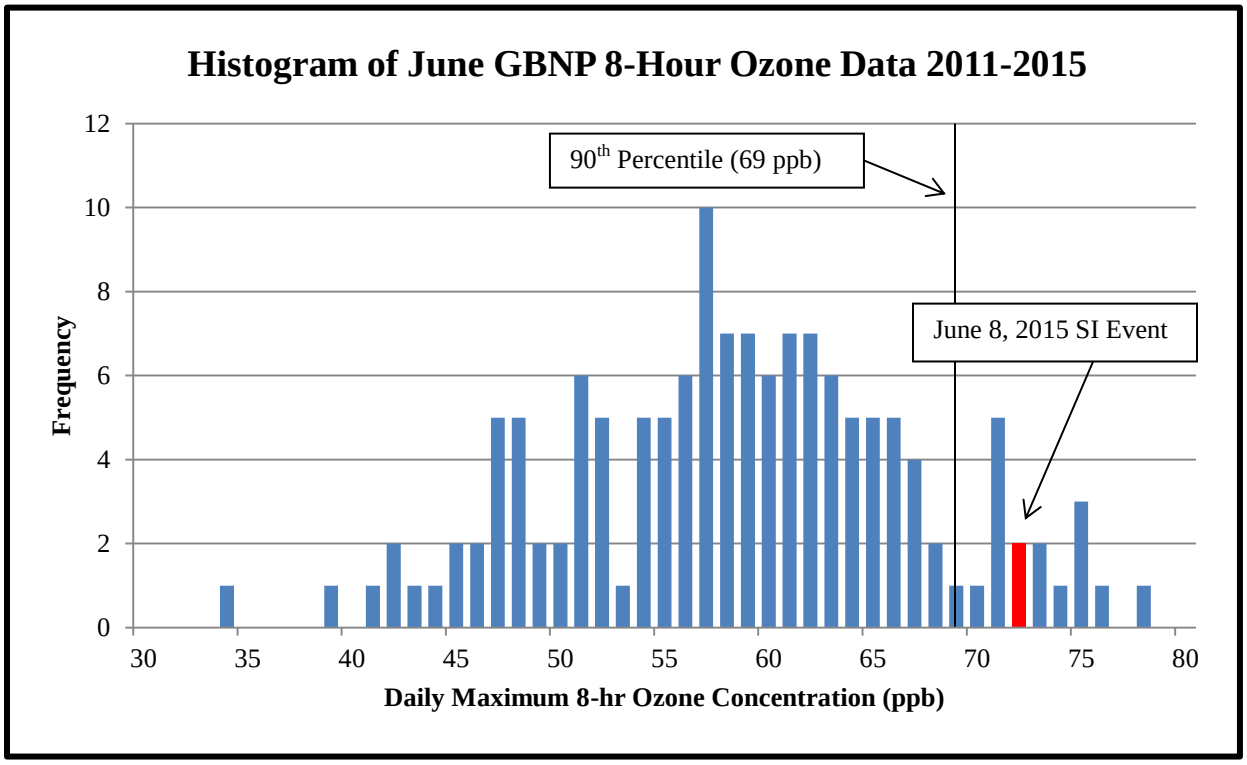
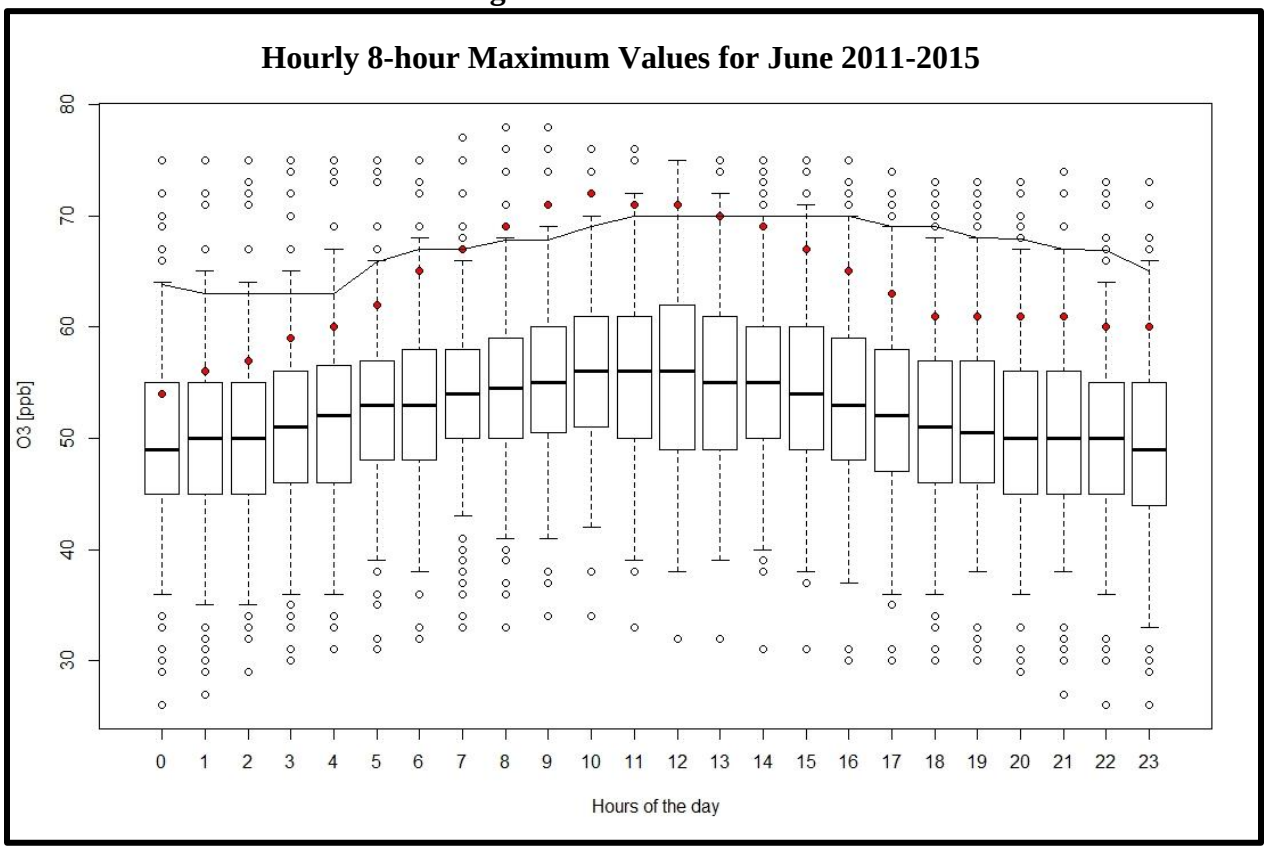


Figure 8 shows the distribution of the hourly 8-hour-averages for O_3 concentrations for each hour of the day in June, as measured from 2011 to 2015. Each box plot describes the interquartile range of the hourly distribution (i.e. 25th to 75th percentile). Whiskers extend to one time the interquartile range from each direction. Data points above and below the whiskers are plotted individually (empty circles) and are considered outliers. The solid black line describes the 95th percentile for each hour of the day. Red filled circles are the values for June 8, 2015. Hours from 8am to 12pm (averages from 8am to 4pm and from 12pm to 8pm, respectively) on June 8, 2015 were all above the 95% percentile. Hours from 7am to 10am were outliers in each hourly distribution.

Figure 8. Box and Whisker Plot of 8-Hour Ozone Concentrations at GBNP for All June Data 2011 through 2015



4.4 EVIDENCE OF A STRATOSPHERIC INTRUSION

4.4.1 Meteorology

On June 3 and 4, 2015 a strong upper level trough formed over the Pacific Coast (Figure 9). A surface low over southern Nevada and the Mojave Desert coincided with the upper level low. Between June 3 and June 9, the north end of the trough moved east across the United States (U.S.)-Canada border, while the low pressure at the southern end of the trough remained roughly stationary over southern California and Nevada. By June 7 and 8, the system consisted of an upper level trough over the upper Midwest U.S. with an associated elongated trough extending from the upper Midwest southwest to California (Figure 10). Surface level winds and pressure reflected the upper level trough in the Midwest U.S., but surface conditions west of the Rocky Mountains did not reflect the elongated trough found in the upper atmosphere.

Figure 9. **Meteorological Plots for 1200 UTC June 4, 2015**. 850 mb Height, Wind Direction, and Temperature (left) and 300 mb Wind Speed, Height, and Wind Direction (right).

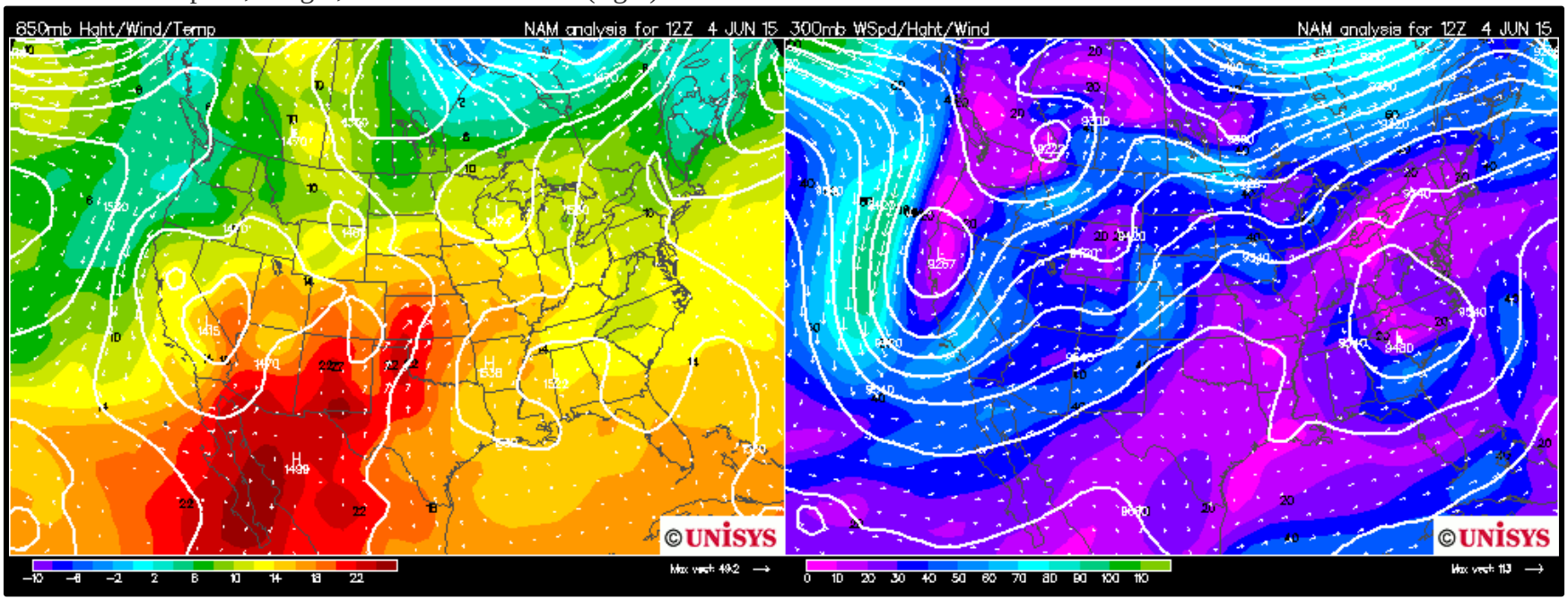
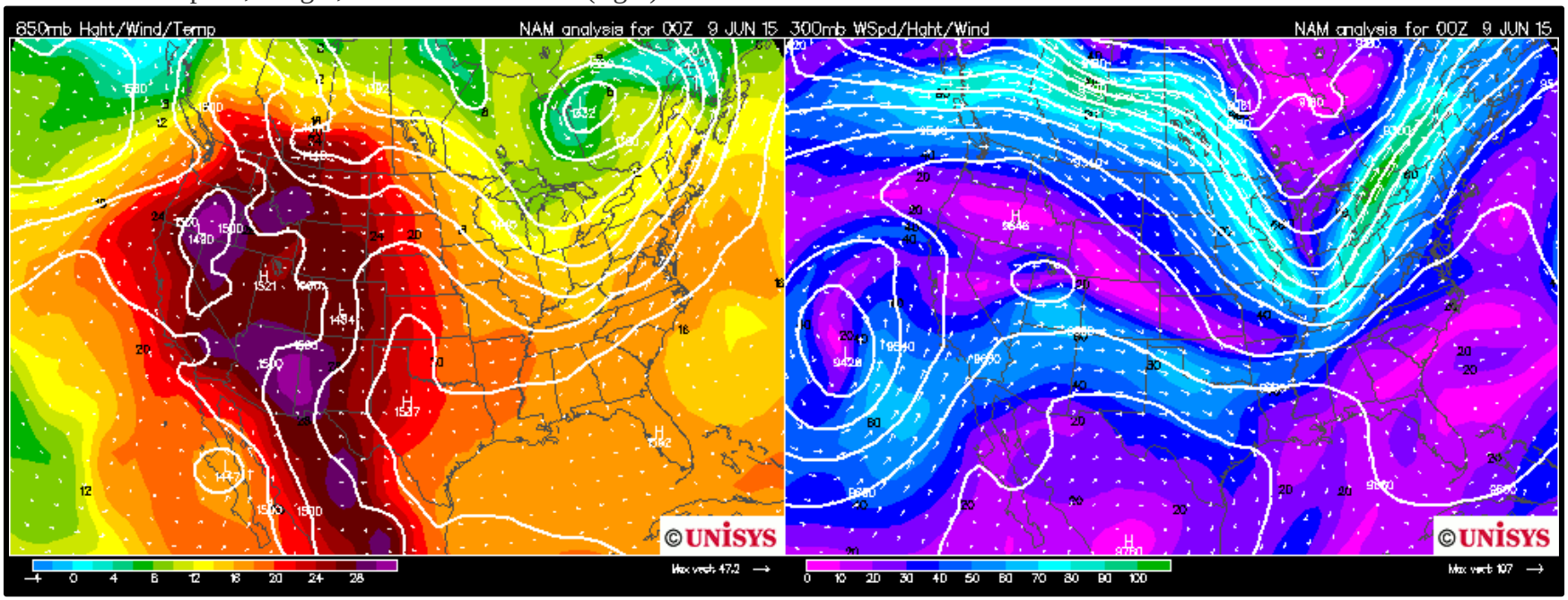


Figure 10. **Meteorological Plots for 0000 UTC June 9, 2015**. 850 mb Height, Wind Direction, and Temperature (left) and 300 mb Wind Speed, Height, and Wind Direction (right).



Surface winds between June 7 and June 9, 2015 were light and primarily from the southwest (Figure 11). High temperatures were increasing throughout the period, ranging from the upper 60s on June 7 to the upper 70s on June 9 (Figure 12).

Figure 11. Wind Rose for GBNP from June 7 through June 9, 2015

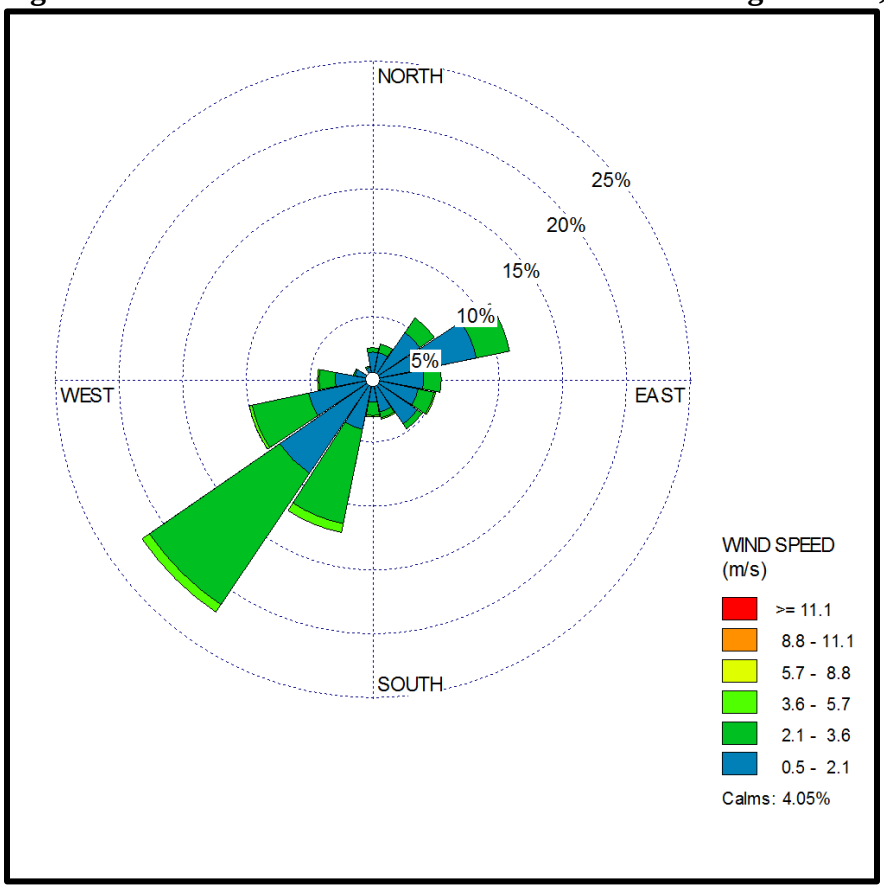
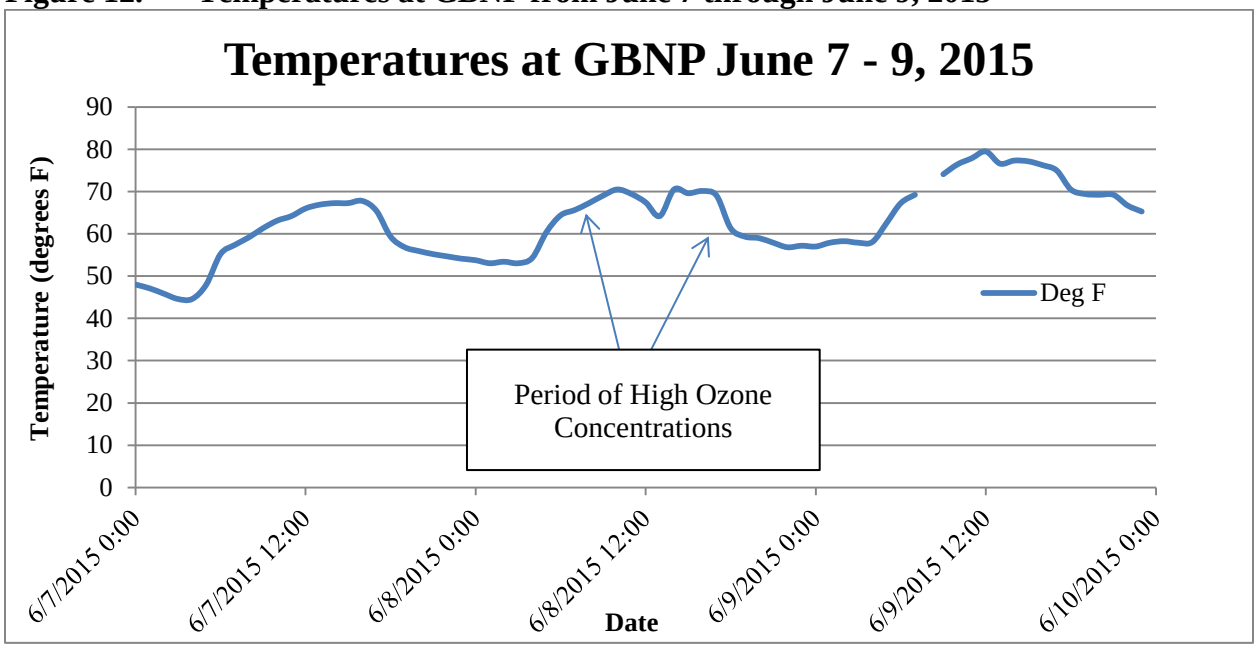


Figure 12. Temperatures at GBNP from June 7 through June 9, 2015



4.4.2 GOES Total Column Ozone Data

Total column ozone can also be used as evidence of a SI. Enhanced total column ozone is commonly observed in regions of folds in the tropopause, which bring stratospheric air (including ozone) down into the upper troposphere. National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES) ozone sounder images from 1300 June 4, 2015 show an area of enhanced total column ozone along the western edge of the upper level trough over the U.S. Pacific coast (Figure 13). Dark and light green areas on the sounding images correspond to regions of increased total column ozone (in Dobson units). The sounding image from 0000 June 9, 2015 shows that the area of enhanced total column ozone has decreased but is still present over east-central Nevada (in the vicinity of GBNP) and central Utah (Figure 14).

Figure 13. GOES Total Column Ozone, 1300 UTC June 4, 2015

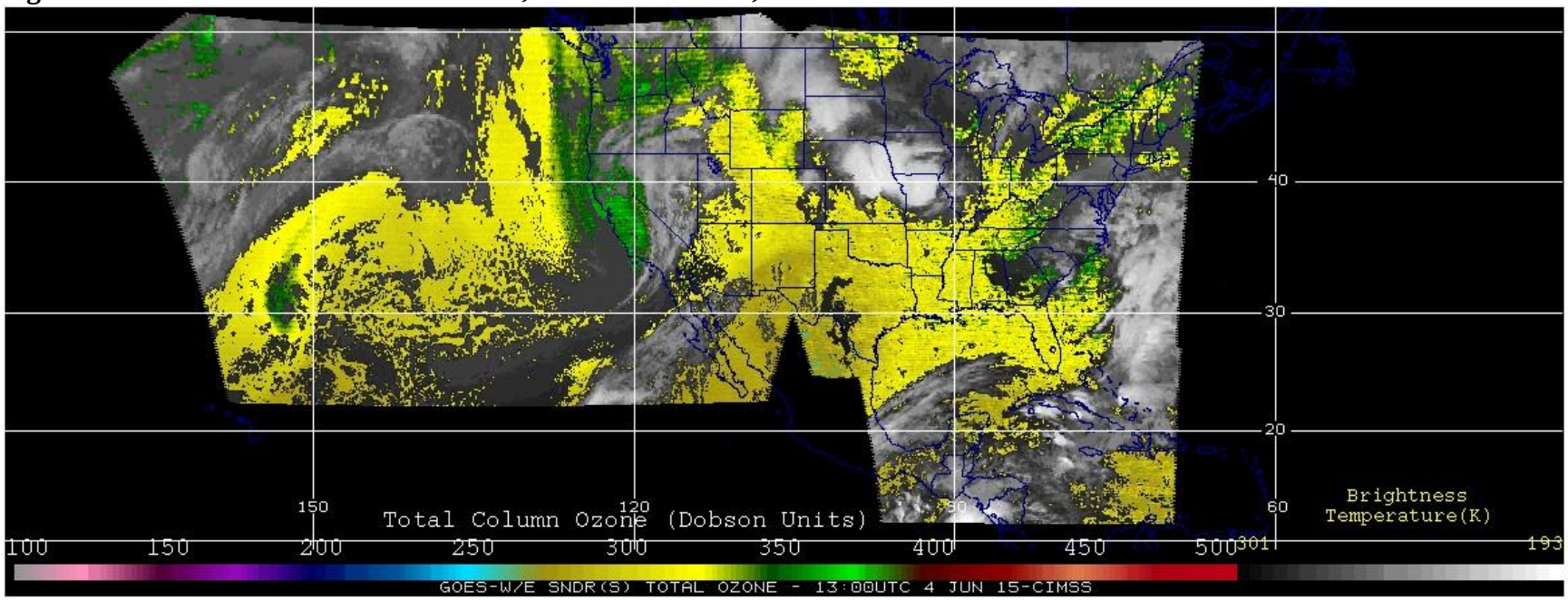
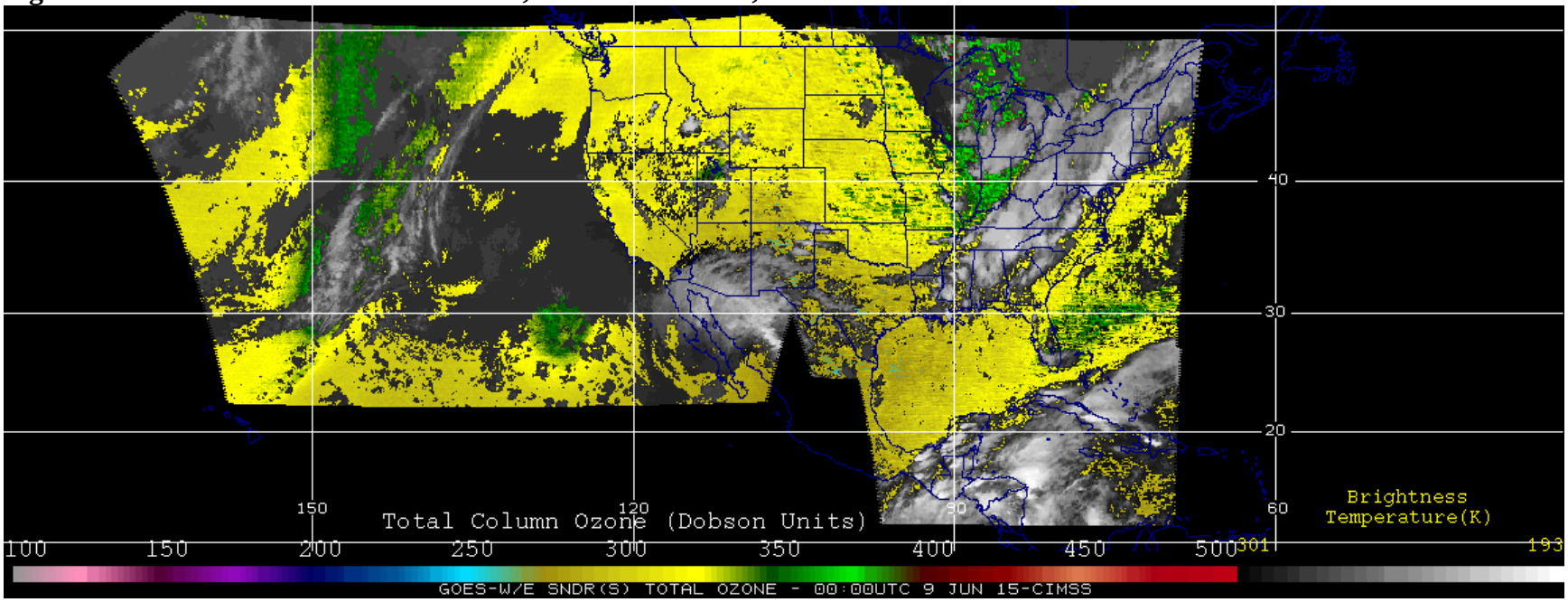


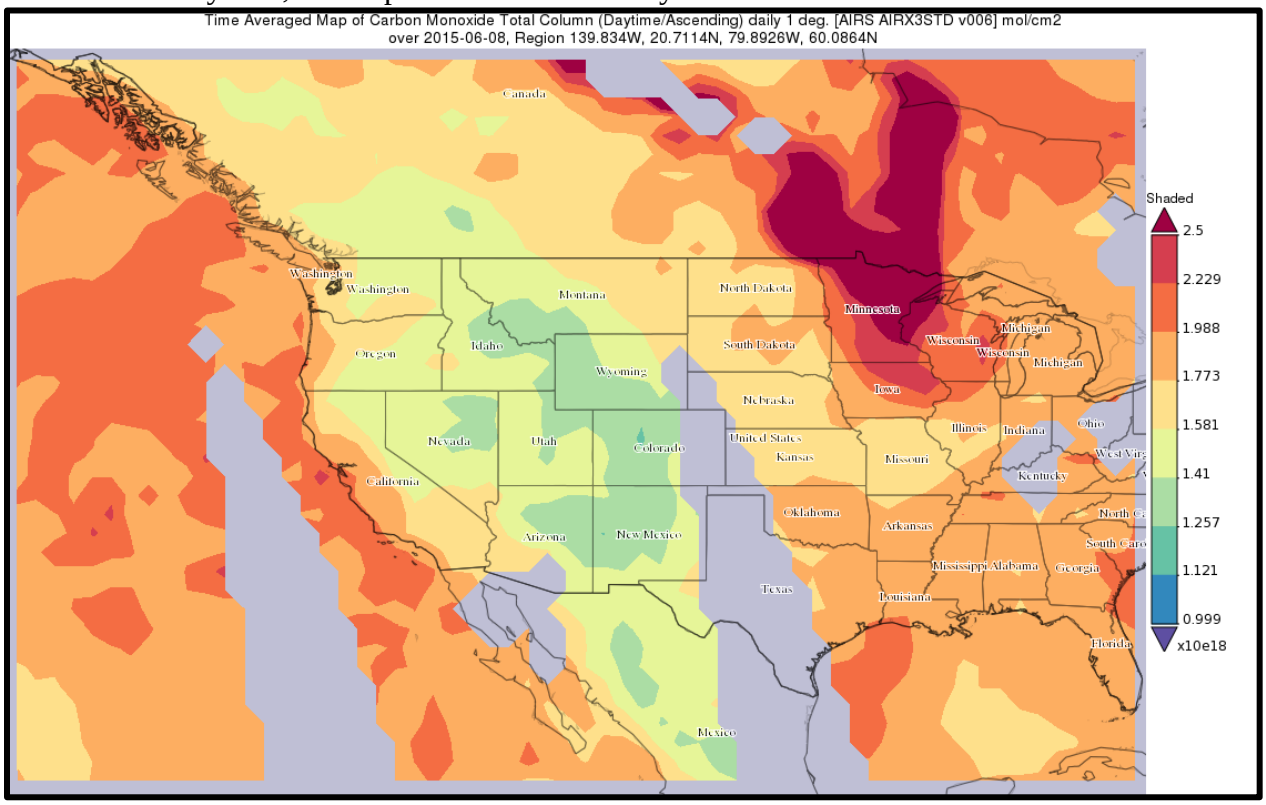
Figure 14. GOES Total Column Ozone, 0000 UTC June 9, 2015



4.4.3 AIRS Satellite Measurements of Carbon Monoxide

Stratospheric air contains very little CO (Pan, et al., 2004; Newell, et al., 1999; Stoller, et al., 1999). Atmospheric Infrared Sounder (AIRS) satellite measurements of total column CO show lower CO concentrations over eastern Nevada on June 8, 2015 (Figure 15). The relatively low concentration of CO over eastern Nevada provides additional evidence in support of an SI event affecting eastern Nevada.

Figure 15. AIRS Satellite-derived Total Column Carbon Monoxide on June 8, 2015 (ascending pass). This figure was produced with the Giovanni online data system, developed and maintained by the NASA GES DISC.



Source: http://giovanni.gsfc.nasa.gov/giovanni/

4.4.4 Isentropic Potential Vorticity

IPV is an indicator of atmospheric spin, and can be used to help identify a SI event. Values of IPV are typically 1- to 1.5-PVU in the troposphere. IPV values greater than 1.5-PVU are commonly interpreted to be an indication of stratospheric air. IPV values were calculated for the 500 millibar (mb) height at 1800 UTC on June 8, 2015, using North American Mesoscale (NAM) Forecast System 12-kilometer data. A map of the IPV values is shown in Figure 16. A vertical cross-section of IPV values was also generated along a north-south transect passing through GBNP (Figure 17). The transect is at approximately 114W longitude, and is shown on Figure 16. The potential vorticity values above GBNP at the time of the elevated ozone concentrations were well above values expected for the troposphere. The vertical cross-section

also shows elevated IPV values in the vicinity of GBNP coincident with the period of high ozone concentrations.

Both images suggest that stratospheric air was folded down into the troposphere over eastern Nevada and western Utah on June 8, 2015. High IPV values were present at the 500 mb height, and occurred at altitudes as low as 4,000 m amsl. This is approximately the middle of the planetary boundary layer, which is generally accepted to be the mixing layer during the day. This suggests that the stratospheric air above GBNP on June 8, 2015 was able to mix down to the surface, resulting in elevated ozone concentrations at the site.

Figure 16. IPV Values at 500 mb Over Portions of the Western U.S. at 1800 UTC June 8, 2015

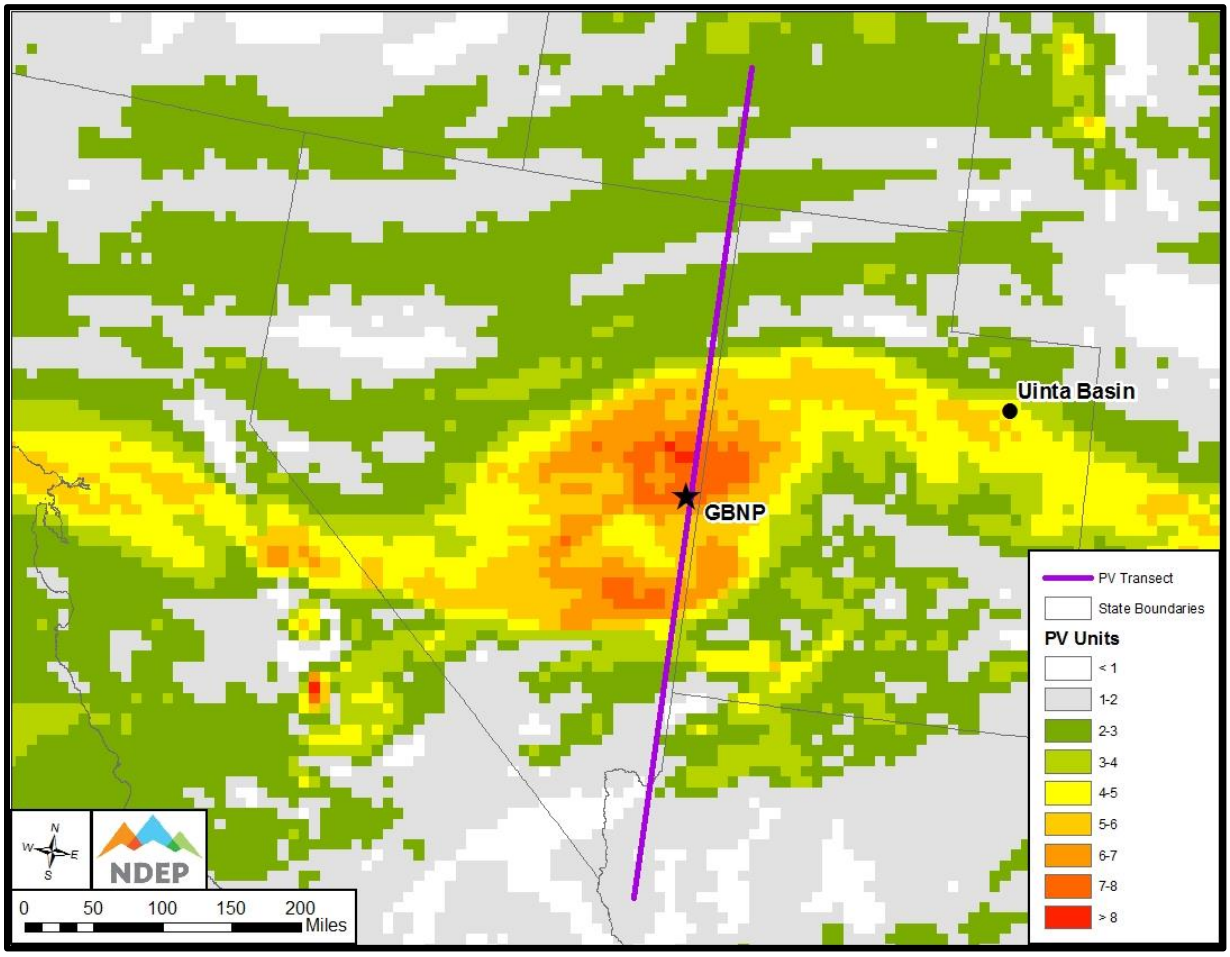
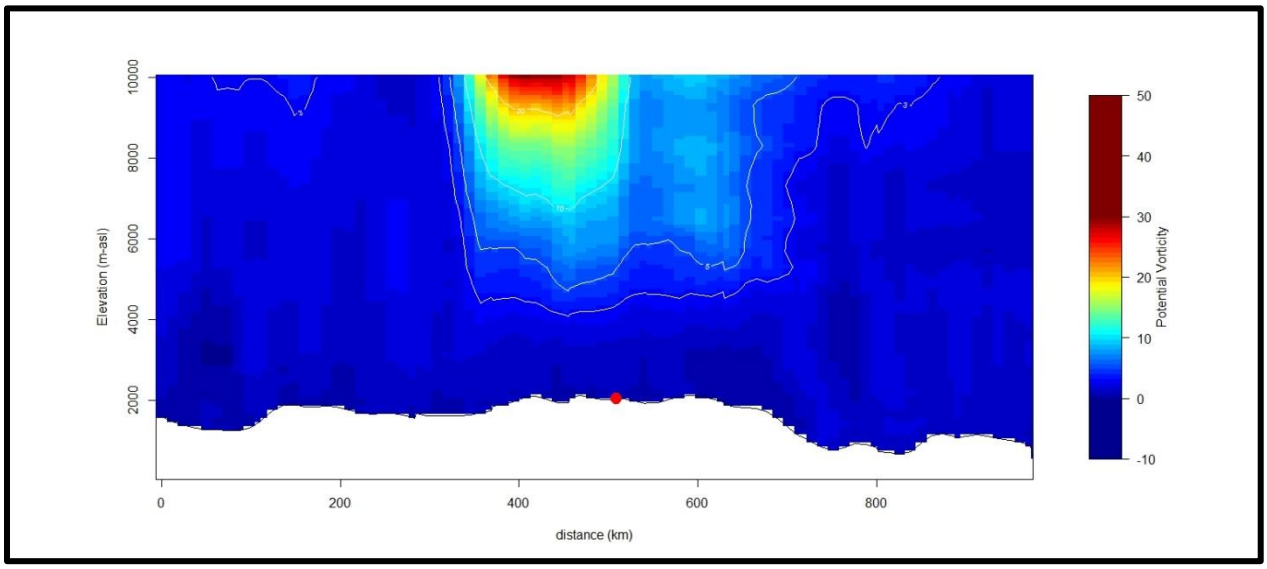


Figure 17. IPV Values Along a North-South Transect at Approximately 114W Longitude at 1800 UTC on June 8, 2015 The red dot is the approximate location of GBNP. The white contour lines delineate 3, 5, 10, and 20 PVU.

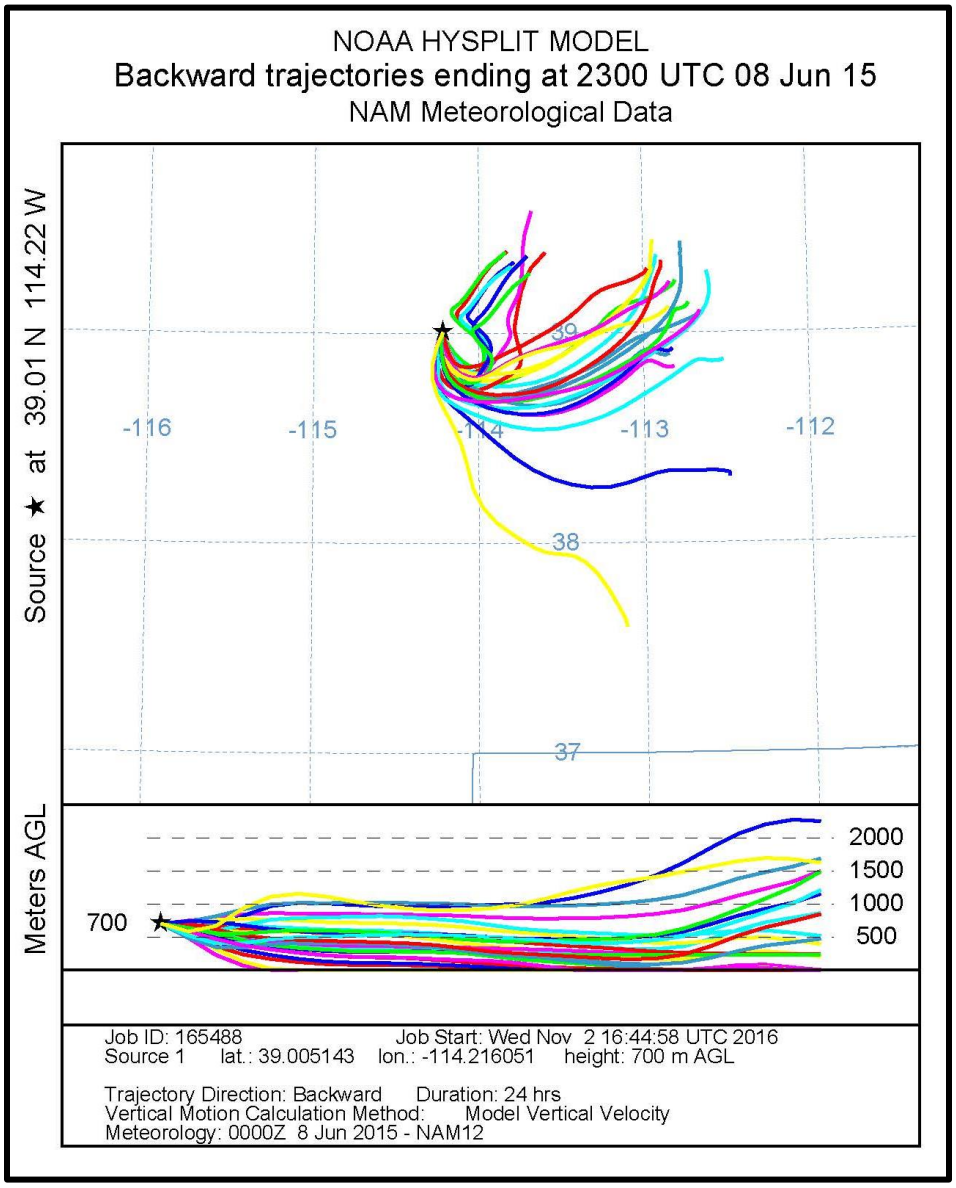


4.4.5 Back-Trajectory Analysis

While cross-section analysis confirms an SI having occurred over eastern Nevada, a trajectory analysis is warranted to examine the path of the ozone-rich air. As shown in Figure 17, the SI descended to at least 4,000 m amsl over eastern Nevada. A back-trajectory analysis was performed using the GBNP monitoring site as a start/endpoint for air parcel trajectories.

Backward trajectories were produced using the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) program with archived NAM 12-km data from June 8, 2015. Instead of analyzing one trajectory, the option of using HYSPLIT in ensemble mode was chosen to provide a more realistic likelihood of the pathway of the stratospheric air. Figure 18 shows an ensemble of backward trajectories starting at 700 meters (m) above ground level (agl) over the GBNP site for 2300 UTC June 8, 2015 for 24 hours. A starting point of 700 m agl was chosen to represent the middle of the planetary boundary layer. Backward trajectories were also generated with starting elevations of 100, 250, and 1,500 m agl for 24 and 72 hours. These trajectories are included in Appendix E. The backward trajectories in Figure 18 show that the air above GBNP on June 8, 2015 came from a variety of heights, ranging from near ground level to more than 2,000 m agl (4,000 m amsl), providing evidence that air from the stratosphere mixed down to the surface.

Figure 18. Backward Trajectories Starting at 700 m agl Above GBNP at 2300 UTC June 8, 2015.



4.4.6 Upper Air RAOBs

A lowering of the tropopause or the existence of a dry air layer is another indication of stratospheric air. The June 8, 2015 radiosonde observations (RAOB) from Elko Nevada, Las Vegas, Nevada, and Salt Lake City, Utah, were analyzed for the presence of SI air. The 0000 UTC June 9, 2015 RAOBs for Salt Lake City, Elko, and Las Vegas all show a dry air layer from 600 to 450 mb (Figures 19-21). The soundings also show that the atmosphere was well-mixed (as shown by the dry adiabatic lapse rate) vertically up to the ozone-laden, dry air layer providing another piece of evidence that supports air from an SI having vertically mixed to the earth's surface.

Figure 19. Radiosonde Observation for Salt Lake City, Utah at 0000 UTC June 9, 2015

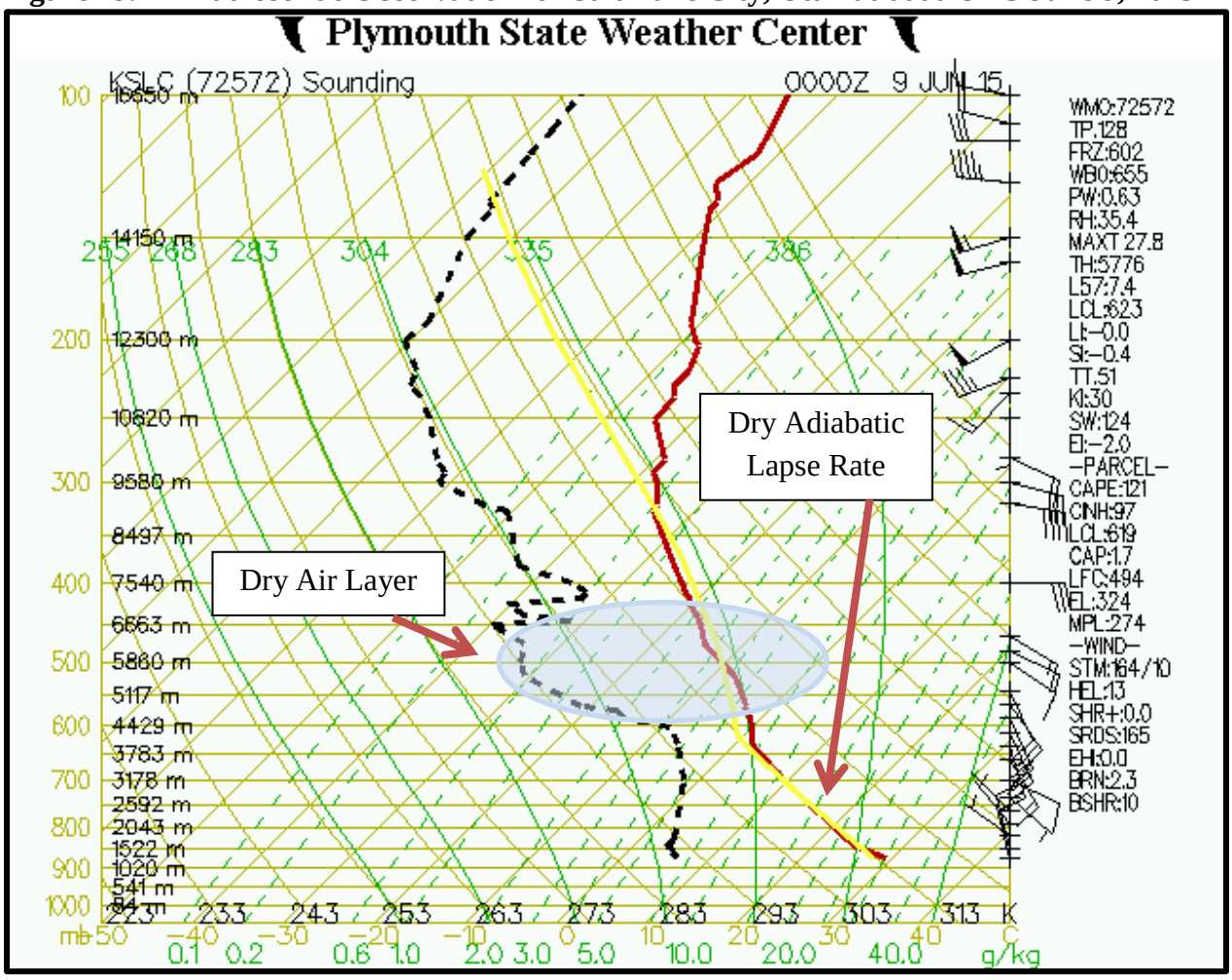


Figure 20. Radiosonde Observation for Las Vegas, Nevada at 0000 UTC June 9, 2015

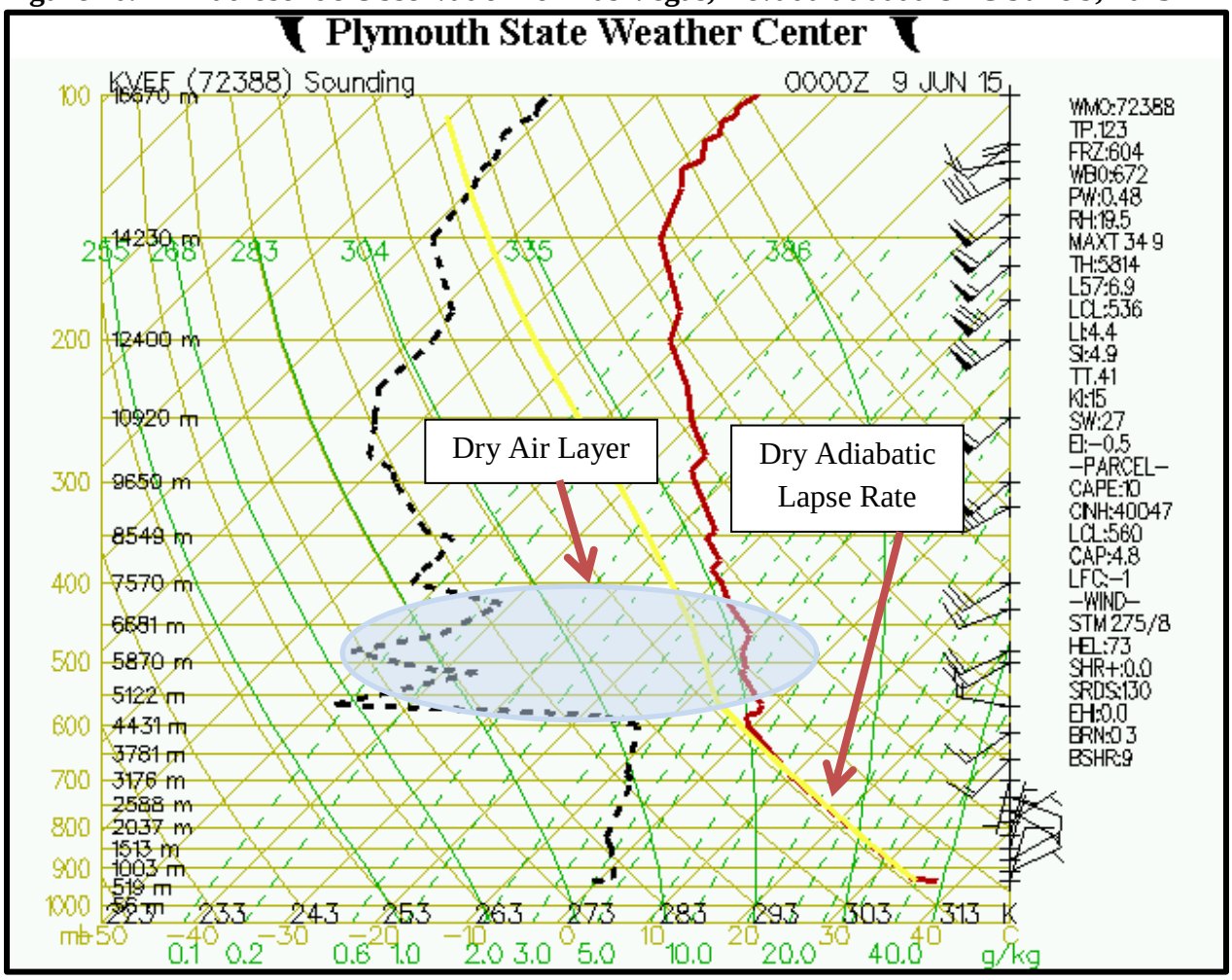
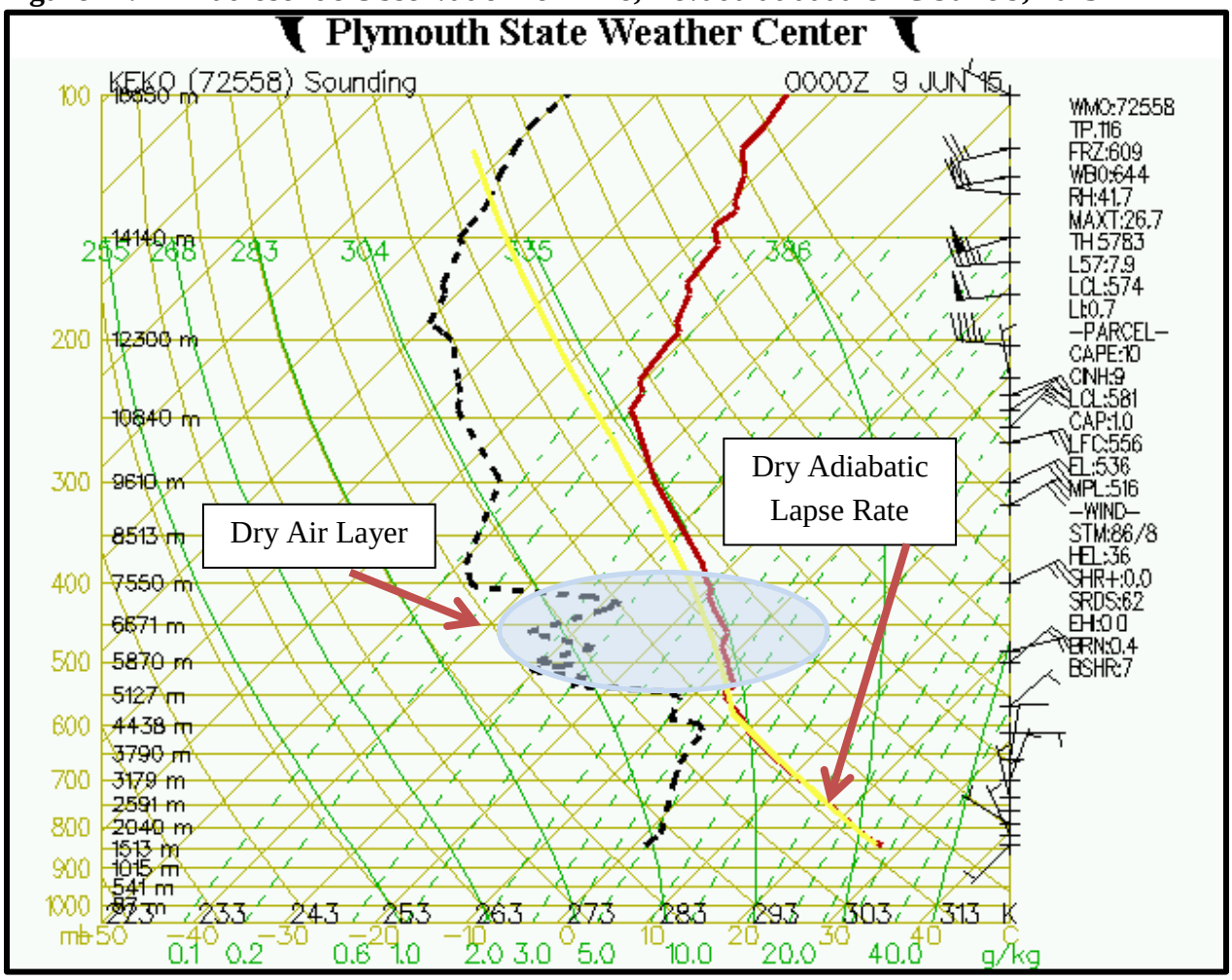


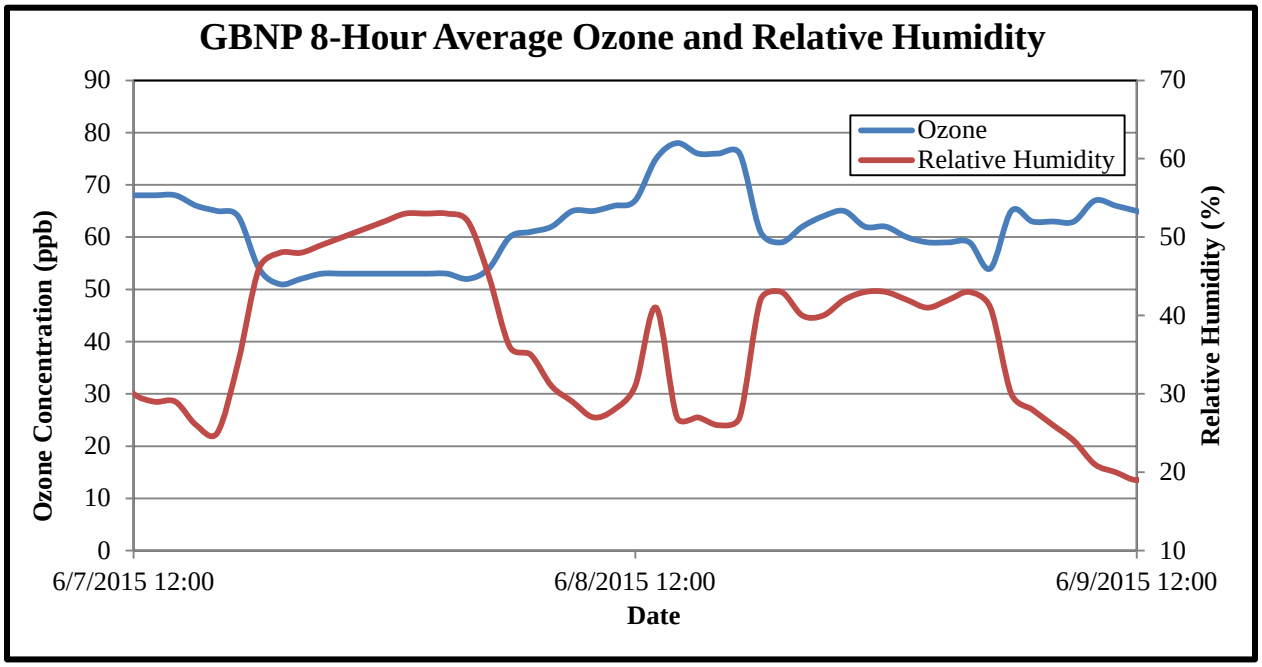
Figure 21. Radiosonde Observation for Elko, Nevada at 0000 UTC June 9, 2015



4.4.7 Surface-Based Data

Figure 22 shows the June 7-9, 2015 1-hour average ozone and hourly RH data for the GBNP monitor. The data show a decrease in RH that coincided with an increase in 8-hour average ozone values. Air of stratospheric origin is dry as depicted by very low RH values. An increase in ozone concentration and a decrease in RH at GBNP is further evidence of an SI event having occurred on June 8, 2015.

Figure 22. Eight-Hour Ozone and One-Hour Relative Humidity Data for June 7-9, 2015 at the GBNP CASTNET Site



4.4.8 Tropopause Heights

The University of Utah Horel Research Group archives tropopause height as given in NAM forecast runs by NOAA and the National Weather Service. Figures 23 and 24 show the tropopause height over the southwestern U.S. at 0000 and 1200 UTC June 6, and 0000 and 1200 June 9, 2015, respectively. The tropopause height maps show an area with the tropopause at or below 450 mb (dark blue and black areas, approximately 21,000 feet altitude) associated with the upper level low over southern California (Figures 9 and 23). The area of lowered tropopause moves eastward and northward over time as the upper level low stretches into an elongated trough. By June 9, 2015 the area of lowered tropopause stretches across northern Nevada and Utah, including GBNP (Figure 25).

Figure 23. NAM Forecast Tropopause Heights for June 6, 2015. NAM forecast from 0000 UTC on June 6, 2015, valid for 0000 UTC June 6, 2015 (left) and 1200 June 6, 2015 (right).

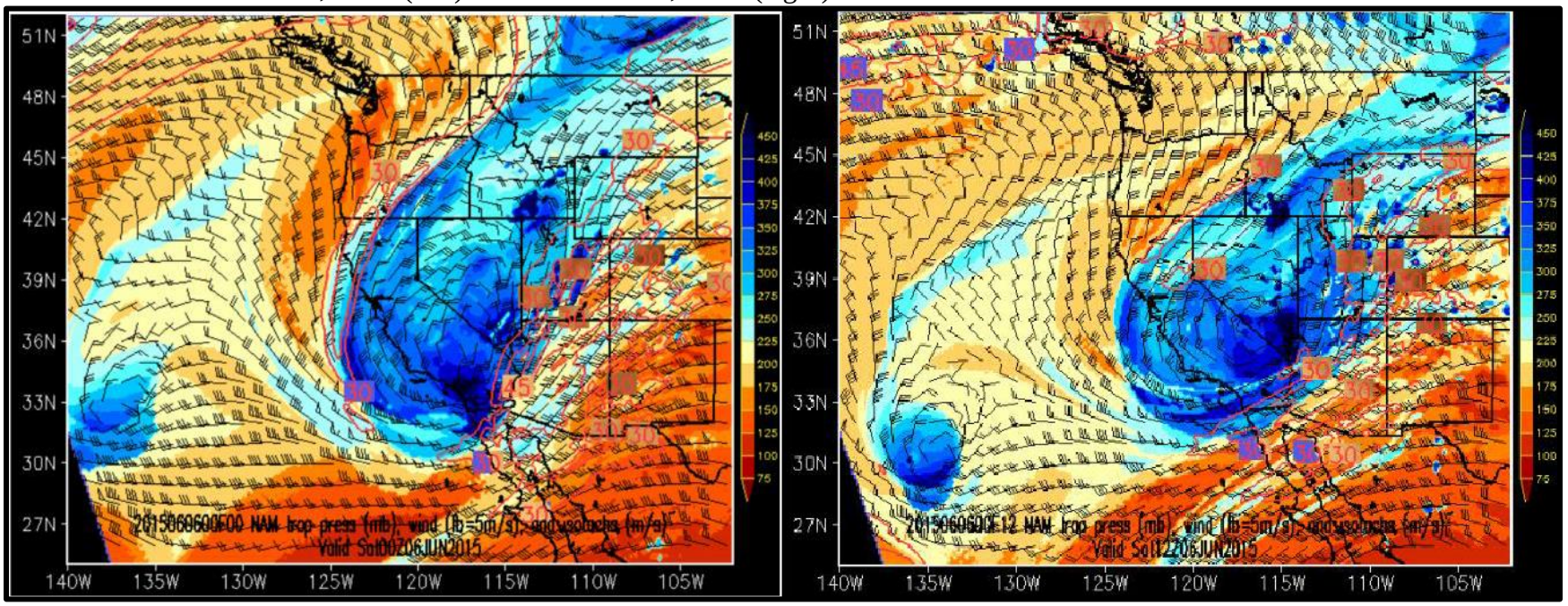
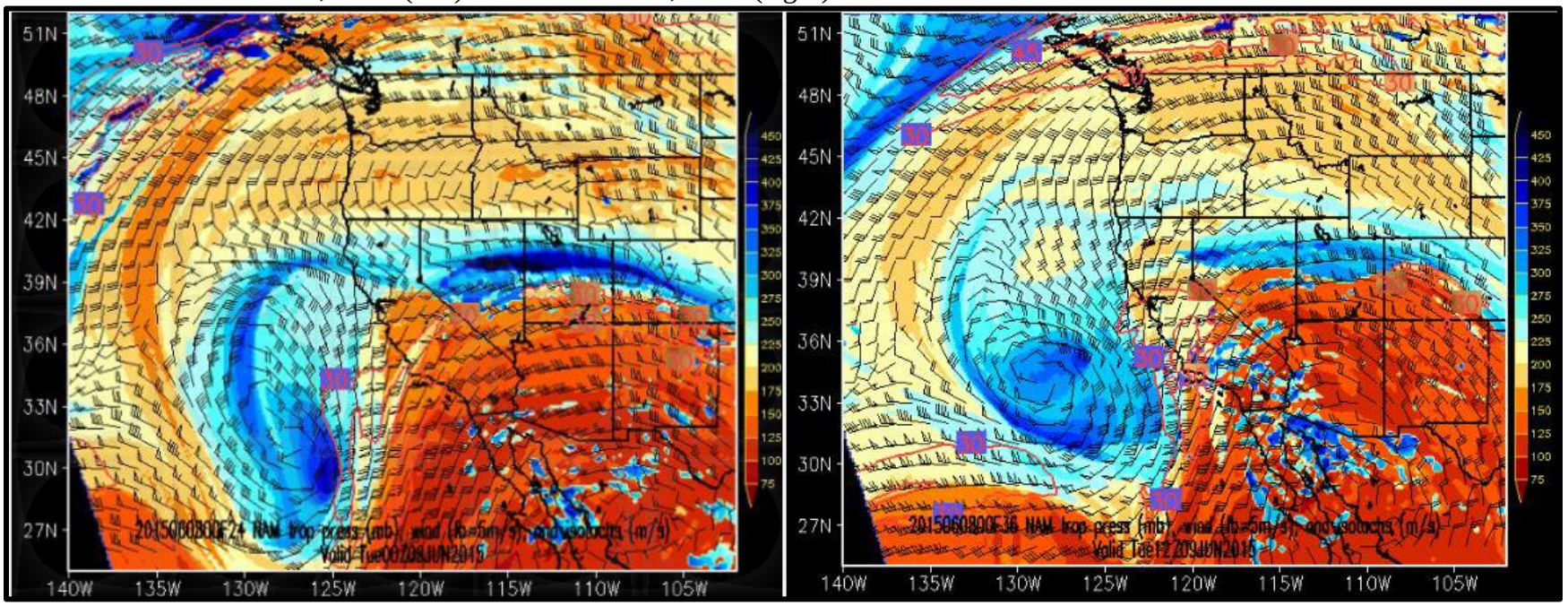


Figure 24. **NAM Forecast Tropopause Heights for June 9, 2015**. NAM forecast from 0000 UTC on June 8, 2015, valid for 0000 UTC June 9, 2015 (left) and 1200 June 9, 2015 (right).



4.4.9 NOAA Realtime Air Quality Modeling System

Images of the vertical distribution of ozone, carbon monoxide, and net ozone production were developed using the NOAA Realtime Air Quality Modeling System (RAQMS) and have been provided by Dr. Brad Pierce. Figures 25 through 27 show RAQMS ozone concentration maps at 5, 3, and 1 km agl at 0000 June 9, 2015. The white dashed line on Figure 25 is the location of the cross-sections shown in Figures 28 and 29. The white star on Figures 25, 28, and 29 is the approximate location of GBNP.

The dashed line at approximately 114 degrees west longitude shows the transect used to generate the RAQMS vertical profile of ozone shown in Figure 28. The transect shows the region of lowered tropopause height from Figure 24, with stratospheric ozone of 80 ppb or higher down to 5 km amsl.

Figure 25. RAQMS Ozone Concentration at 5 km agl at 0000 UTC June 9, 2015.

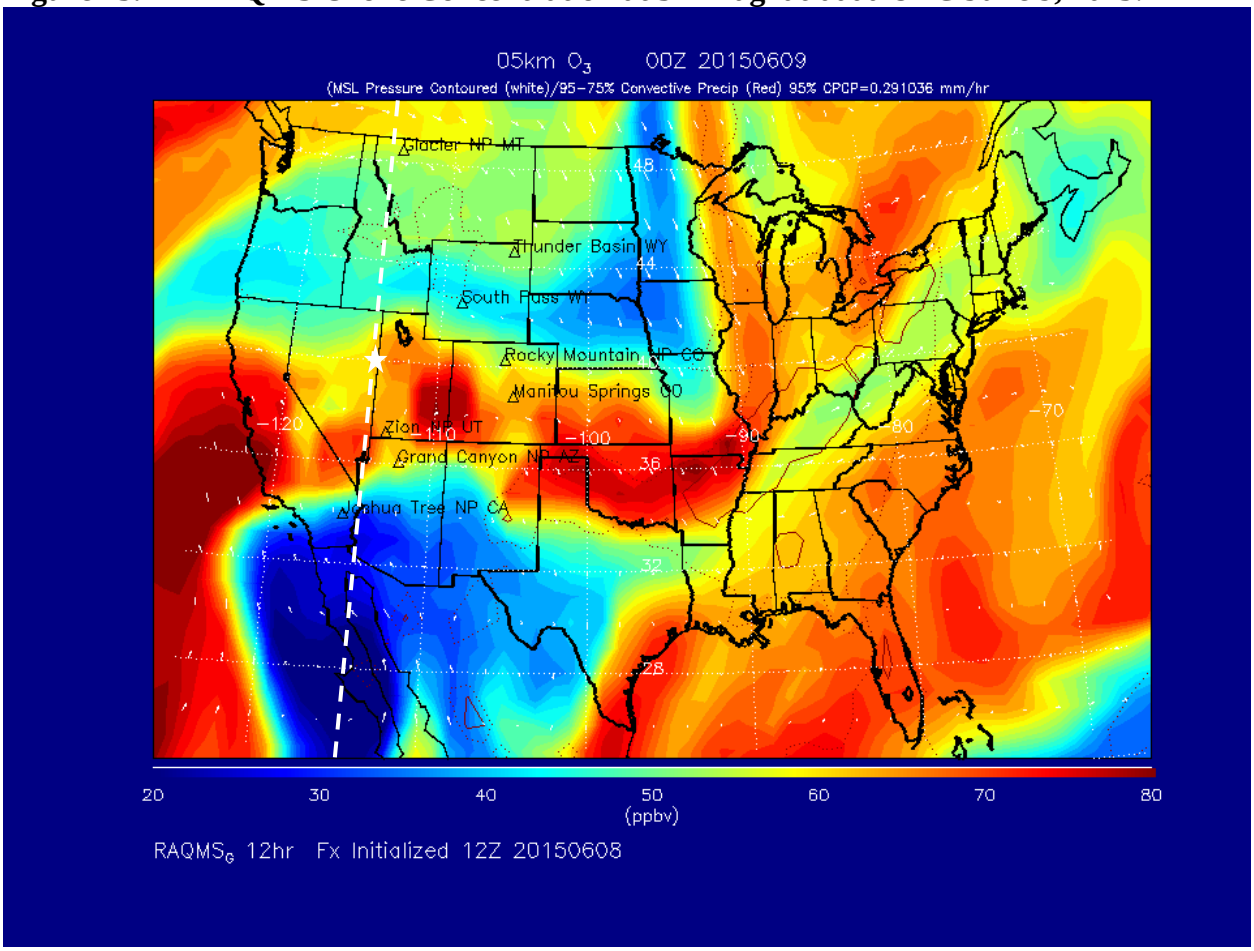


Figure 26. RAQMS Ozone Concentration at 3 km agl at 0000 UTC June 9, 2015

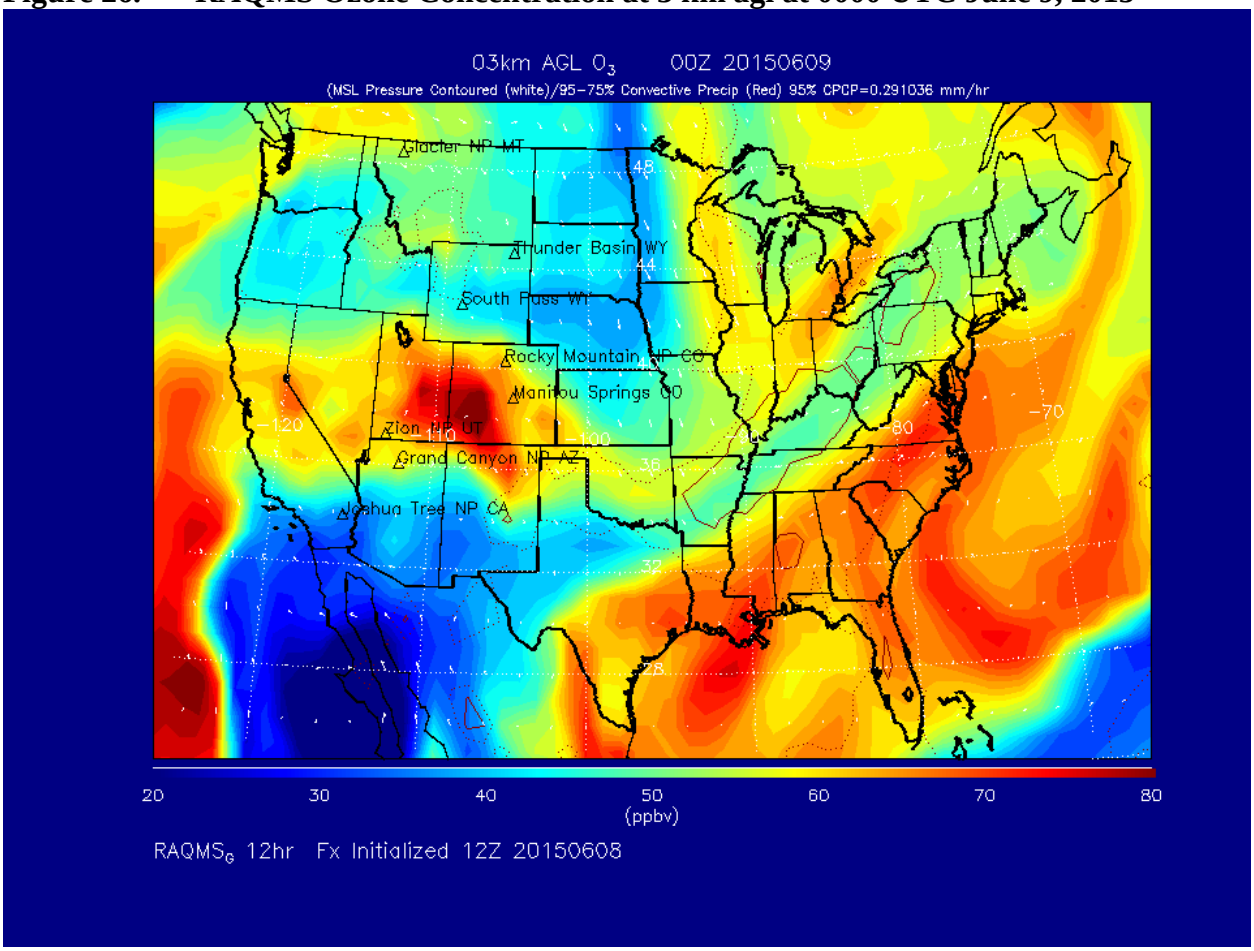


Figure 27. RAQMS Ozone Concentration at 1 km agl at 0000 UTC June 9, 2015

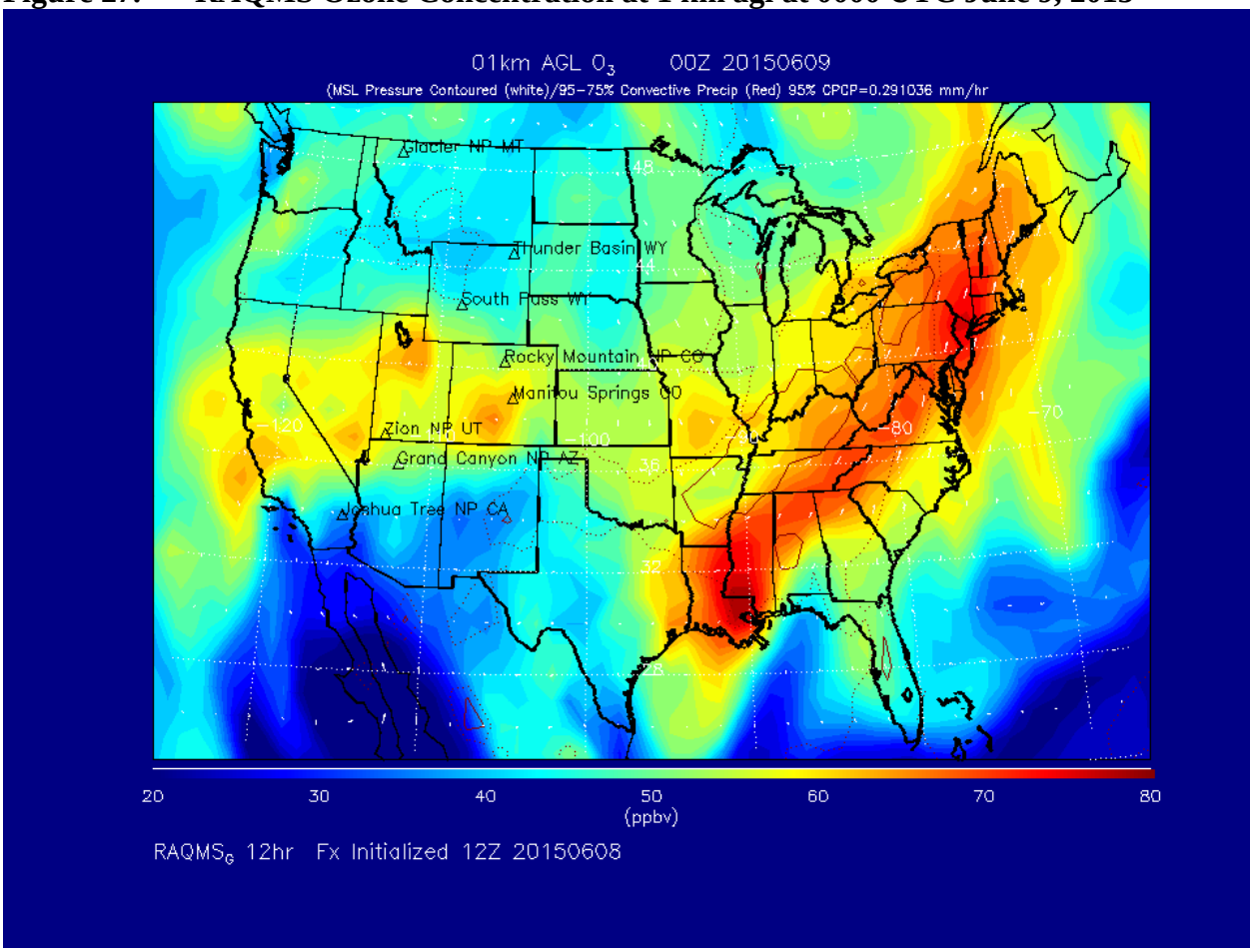


Figure 28. RAQMS Ozone Vertical Profile 0000 UTC June 9, 2016 at 114 Degrees West.

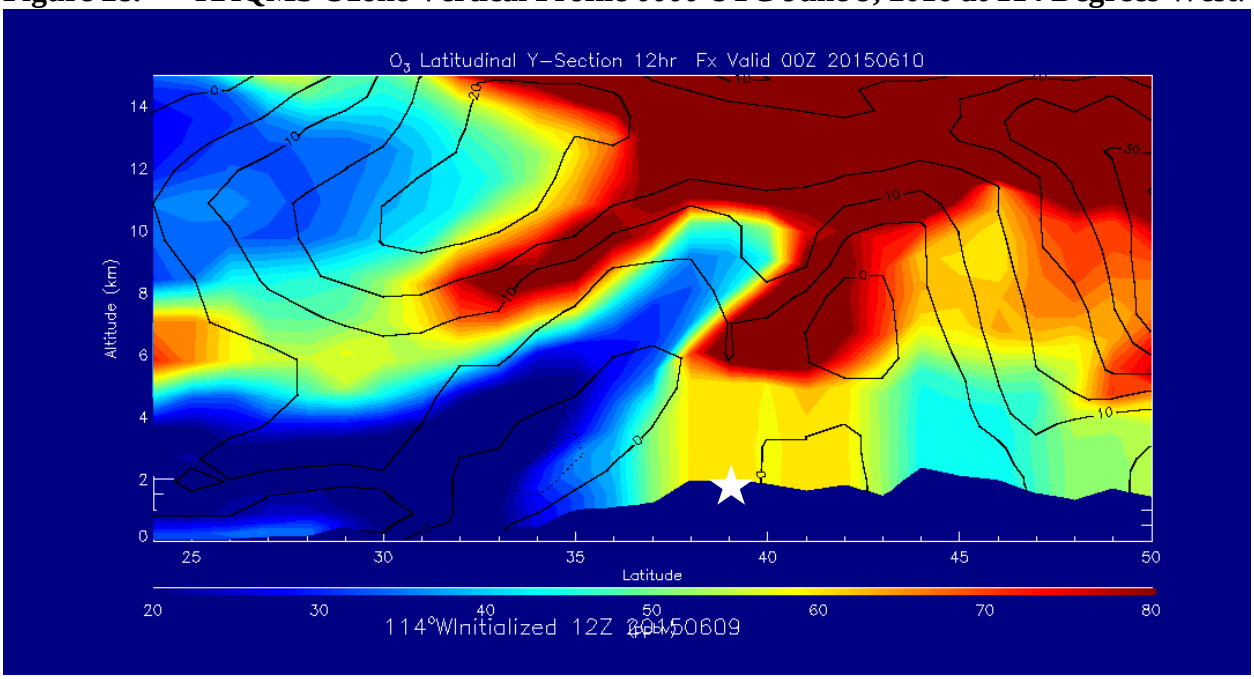
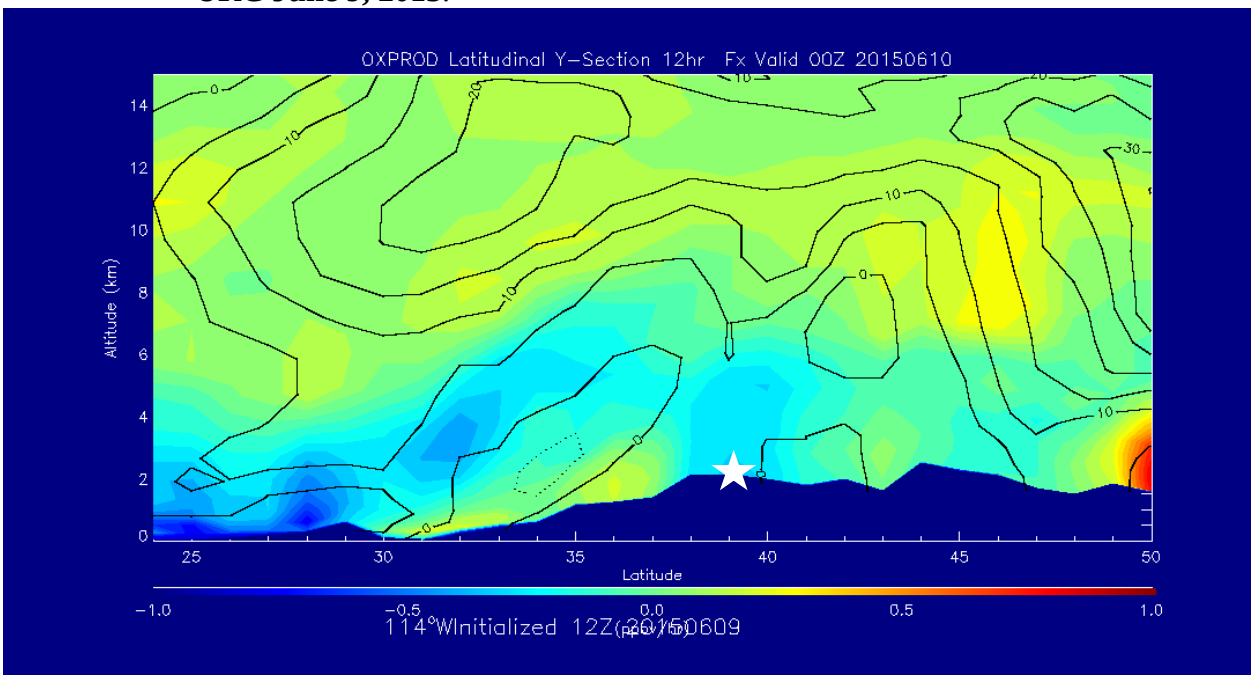


Figure 29 shows RAQMS estimates of local oxidant production rates. Elevated oxidant production due to local photochemistry is seen for Calgary, Alberta (51 °N, 114 °W), and a minimum in local photochemical oxidant production is shown for GBNP (39 °N, 114 °W). The RAQMS result suggests that local photochemistry played little or no role in the elevated ozone at GBNP on June 8, 2015.

Figure 29. RAQMS Predicted Local Photochemical Oxidant Production Rates for 0000 URC June 9, 2015.



5.0 SUMMARY AND CONCLUSIONS

During the interval from late winter to late spring in the northern hemisphere, weather producing systems (i.e. tropospheric storm systems, upper level disturbances or upper level storm systems) aid in causing the tropopause to "fold" or descend into the troposphere where our weather occurs. Tropopause folding permits ozone-rich air from the stratosphere to enter the troposphere, also called a stratospheric intrusion (SI), creating the potential for ground level ozone monitors over the higher terrain of the western U.S. to experience elevated readings.

During the period from June 4 through 8, 2015, an upper atmospheric disturbance associated with an SI moved over the western U.S. injecting ozone-rich air into the troposphere. The ozone-laden air then moved over eastern Nevada, generating elevated ozone readings resulting in an 8-hour ozone standard exceedance of 72 ppb at the GBNP ozone monitoring site. Ozone monitors managed by the Ute Tribe in central Utah also measured elevated 1-hour average ozone values during the SI event (Figure 4).

Statistical analyses performed on the GBNP data show that the June 8, 2015 ozone data was statistically higher than values recorded during June of each year from 2011 through 2015.

This document clearly shows that an upper atmospheric disturbance and its attendant SI carried ozone-rich air from the stratosphere over eastern Nevada down to the area around the GBNP ozone monitor on June 8, 2015. Due to the disturbance, atmospheric conditions were conductive for a tropopause fold and vertical mixing over the GBNP area as evidenced by meteorological data, ozone and CO data, backward trajectories, upper air soundings, and IPV values. As a result, 1-hour average ozone values at the GBNP ozone monitor increased on June 8, 2015.

The event meets the definition of a stratospheric intrusion as outlined in the preamble to "Treatment of Data Influenced by Exceptional Events" 40 CFR Parts 50 and 51 section IV(D)(5)(e). Specifically, air originated in the stratosphere and was transported directly to the earth's surface via an upper level disturbance causing the GBNP June 8, 2015 exceptional event. This event meets the specific criterion established in 40 CFR 50.14 (3)(iii) as described below.

Based on the evidence, including the comparisons and analyses provided in Section 4 of this demonstration, the NDEP has established that a clear causal relationship exists between the stratospheric intrusion event on June 8, 2015 in eastern Nevada, and the monitored ozone exceedance on that day. The clear causal relationship evidence also demonstrates that the event affected air quality at the monitor, and that the event is associated with a measured concentration in excess of normal historical concentrations for this site, including background.

5.1 AFFECTS AIR QUALITY

Figure 4 shows that rural, remote high elevation ozone monitors in the western United States observed elevated ozone levels on June 3 and 4 and on June 7, 8 and 9, 2015. Figure 5 shows maps of measured ozone in the region on June 8, 2015, showing the geographic extent of the elevated ozone. Section 4 provided evidence that the elevated ozone observed was caused in part by stratospheric ozone affecting surface air quality.

5.2 NATURAL EVENT

The Exceptional Events Rule states a '[n]atural event means an event and its resulting emissions, which may recur at the same location, in which human activity plays little or no direct causal role'. The analysis shows that ozone transported via a stratospheric ozone intrusion caused the identified exceedance discussed in Section 4 of this demonstration. The NDEP concludes that the event identified should be considered a natural, stratospheric ozone intrusion event.

5.3 NOT REASONABLY CONTROLLABLE OR PREVENTABLE

The Exceptional Events Rule Preamble and the 40 CFR 50.14 specifically list stratospheric intrusion of ozone as a natural event that could affect ground level ozone concentrations. The analysis shows that ozone transported via a stratospheric ozone intrusion caused the identified exceedance discussed in Section 4 of this demonstration. The NDEP concludes that the event in question was a stratospheric ozone intrusion event and thereby an unpreventable and uncontrollable natural event, and therefore not reasonably controllable or preventable.

In summary, the NDEP concludes that an SI occurred on June 8, 2015 resulting in an exceptional event. This exceptional event has passed the three criterion tests under 40 CFR 50.14 (6). Consequently, the NDEP is requesting for EPA concurrence that the event was exceptional and for the exclusion from the AQS database of the GBNP CASTNET 1-hour average ozone data for the following times:

6.0 PROCEDURAL REQUIREMENTS

6.1 FLAGGING OF DATA

At the request of the NPS, ARS has submitted the ozone data from the GBNP CASTNET ozone monitor to the U.S. EPA AQS database. At the request of NDEP, ARS has placed the appropriate flags on the data indicating that the data was affected by exceptional events due to wild fires (Flag RT, requesting exclusion due to wildland fires). Such flagging ensures that the air quality data is properly represented in the overall air quality planning process.

6.2 PUBLIC OUTREACH DURING EVENT

A state requesting exclusion of air quality data affected by an exceptional event must take appropriate and reasonable actions to protect public health from exceedances or violations of the national ambient air quality standards. At a minimum, the state must:

- provide for prompt public notification whenever air quality concentrations exceed or are expected to exceed an applicable ambient air quality standard;
- provide for public education concerning actions that individuals may take to reduce exposures to unhealthy levels of air quality during and following an exceptional event; and
- provide for the implementation of appropriate measures to protect public health from exceedances or violations of ambient air quality standards caused by exceptional events.

The public was notified of air quality being affected by ozone via Air Quality Index (AQI) updates on the AirNow website (Appendix C).

6.3 PUBLIC COMMENT PERIOD

The NDEP BAQP has prepared this documentation to demonstrate that these exceedances were due to wildland fire natural events, in accordance with the U.S. EPA Exceptional Event Rule. The documentation in support of this demonstration and request for the treatment of the data associated with these exceedances as exceptional events was posted on the NDEP website at http://ndep.nv.gov/admin/public.htm requesting review and comment by the public for a minimum of 30 days. Public comments were directed to:

Sheryl Fontaine, Ambient Air Monitoring Branch
Nevada Division of Environmental Protection
Bureau of Air Quality Planning
901 South Stewart Street, Suite 4001
Carson City, Nevada 89701
Email: sfontaine@ndep.nv.gov

7.0 REFERENCES

American Meteorological Society. "Glossary of Meteorology." *AMS Glossary.* 2010. http://amsglossary.allenpress.com/glossary (accessed 2010).

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United States Environmental Protection Agency (U.S. EPA). 2015. *The Treatment of Data Influenced by Exceptional Events* (81 FR 68216).

Ute Tribe. 2016. Technical Support Documentation Ozone NAAQS Exceedances Occurring June 8 and 9, 2015 Uinta Basin of Utah. 54pp.

APPENDIX A

NDEP BAQP Annual Network Plan Approval Letter

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

OCT 2 8 2015

Mr. Phillip Shoopman
Chief, Bureau of Air Quality Planning
Nevada Division of Environmental Protection
901 south Stewart Street, Suite 4001
Carson City, Nevada 89701

Dear Mr. Shoopman:

Thank you for your submission of the 2015 *Ambient Air Monitoring Network Plan* for the State of Nevada in June 2015. We have reviewed the submitted document based on the requirements set forth under 40 CFR 58. Based on the information provided in the plan, the U.S. Environmental Protection Agency (EPA) approves all portions of the network plan except those specifically identified below.

Please note that we cannot approve portions of the annual network plan for which the information in the plan is insufficient to judge whether the requirement has been met, or for which the information, as described, does not meet the requirements as specified in 40 CFR 58.10 and the associated appendices. EPA Region 9 also cannot approve portions of the plan for which the EPA Administrator has not delegated approval authority to the regional offices. Accordingly, the first enclosure (*A. Annual Monitoring Network Plan Items where EPA is Not Taking Action*) provides a listing of specific items of your agency's annual monitoring network plan where EPA is not taking action. The second enclosure (*B. Additional Items Requiring Attention*) is a listing of additional items in the plan that EPA wishes to bring to your agency's attention.

The third enclosure (C. *Annual Monitoring Network Plan Checklist*) is the checklist EPA used to review your plan for overall items that are required to be included in the annual network plan along with our assessment of whether the plan submitted by your agency addresses those requirements.

The first two enclosures highlight a subset of the more extensive list of items reviewed in the third enclosure. All comments conveyed via this letter (and enclosures) should be addressed (through corrections within the plan, additional information being included, or discussion) in next year's annual monitoring network plan.

We also want to thank you for your timely submission of the 2015 *Five Year Ambient Air Monitoring Network Assessment* for the State of Nevada, as required under 40 CFR Part 58.10. We recognize that preparing the network assessment was a significant project and we appreciate your effort.

The recently revised ozone NAAQS, finalized on October 1, 2015, includes language that revokes all existing seasonal ozone waivers upon the effective date of the final rule. EPA Region 9 will consider all previously approved ozone season waivers effective until December 31, 2015. In advance of the 2016 ozone monitoring season (January – December), EPA Region 9 recommends that agencies seeking new ozone waivers for the 2015 8-hour Ozone NAAQS of 0.070 ppm submit waiver requests no later than December 1, 2015.

If you have any questions regarding this letter or the enclosed comments, please feel free to contact Meredith Kurpius at (415) 947-4534 or Michael Flagg at (415) 972-3372.

Sincerely,

Gretchen Busterud
Acting Deputy Director, Air Division

Enclosures:

A. Annual Monitoring Network Plan Items where EPA is Not Taking Action
B. Additional Items Requiring Attention
C. Annual Monitoring Network Plan Checklist

cc: Mike Elges, NDEP
cc (via email): Daren Winkelman, NDEP

A. Annual Monitoring Network Plan Items where EPA is Not Taking Action

We are not acting on the portions of annual network plans where either EPA Region 9 lacks the authority to approve specific items of the plan, or EPA has determined that a requirement is either not met or information in the plan is insufficient to judge whether the requirement has been met.

- System modifications (e.g., site closures or moves) are subject to approval per 40 CFR 58.14(c). Information provided in the plan was insufficient for EPA to approve the system modifications listed in the plan per the applicable requirement. Therefore, we are not acting on the following items as part of this year's annual network plan (see Checklist Rows 4 and 16):
    - Shutdown of Harvey CO SLAMS monitor

EPA identified items in your agency's annual monitoring network plan where a requirement was not being met or information in the plan was insufficient to judge whether the requirement was being met based on 40 CFR 58.10 and the associated appendices. Therefore, we are not acting on the following items:

Item	Checklist Row	Issue
Modifications to SLAMS network	3	Insufficient information to judge
Sampling schedule for $PM_{2.5}$ - applies to year-round and seasonal sampling schedules	31	Insufficient information to judge
Designation of a primary monitor if there is more than one monitor for a pollutant at a site.	15	Insufficient information to judge
FRM/FEM/ARM $PM_{2.5}$ QA collocation	23	Insufficient information to judge
Document how states and local agencies provide for the review of changes to a $PM_{2.5}$ monitoring network that impact the location of a violating $PM_{2.5}$ monitor.	19	Insufficient information to judge
Distance of monitor from nearest road	74	Not meeting requirement
Traffic count of nearest road	75	Not meeting requirement
Distance from supporting structure	78	Insufficient information to judge
Distance from obstructions not on roof (horizontal distance to the obstruction and vertical height of the obstruction above the probe should be provided)	80	Insufficient information to judge
Monitor type for each monitor, and Network Affiliation(s) as	69	Incorrect in one instance

appropriate		
Scale of representativeness for each monitor as defined in Appendix D	70	Incorrect in one instance
Parameter code for each monitor	71	Incorrect in one instance
Basic monitoring objective for each monitor	67	Incorrect in one instance

B. Additional Items Requiring Attention

- [Item 21] Minimum monitoring requirements for $PM_{2.5}$ only apply to Metropolitan Statistical Areas. Since Gardnerville Ranchos is a Micropolitan Statistical Area, there are no monitors currently required for this area by 40 CFR 58 Appendix D. Also, as a general note, SPMs do not count towards meeting minimum monitoring requirements. Also, please note that the requirement for population is by MSA, not county.

  The minimum monitoring requirements for $PM_{2.5}$ are specified in 40 CFR 58 Appendix D 4.7.1(a): "State, and where applicable local, agencies must operate the minimum number of required $PM_{2.5}$ SLAMS sites listed in Table D-5 of this appendix." Please correct Table 2 to reflect the number of SLAMS sites, rather than monitors.

  According to information provided in the site tables, Table 2 should indicate that there is 1 active site in the Carson MSA and either remove the for Gardnerville Ranchos or list 0 active sites, as the only monitor is not a SLAMS, but an SPM.

- [Item 22] Since there are 0-1 $PM_{2.5}$ SLAMS sites required for the Carson City MSA, 40 CFR Appendix D 4.7.2 requires 0-1 continuous monitor in the MSA. No information was given in the site table to indicate whether the continuous monitor is primary.

- [Item 25] There is a in the site tables called "Suitable for $PM_{2.5}$ comparison", though this is likely the asking for "suitable for annual $PM_{2.5}$ comparison." Please correct in future plans.

- [Item 35] The information provided in your plan for the required number of PM_{10} monitoring sites required by 40 CFR 58 Appendix D is incorrect. The population threshold for MSAs requiring PM_{10} monitoring is 100,000. In your next plan, please note that there are no requirements per 40 CFR 58 Appendix D for PM_{10} monitoring in the Carson City MSA and also none required in Micropolitan Statistical Areas, such as Elko and Pahrump. Please correct the information in your next plan to evaluate the requirement for each area separately, and indicate that there are no sites required in Micropolitan Statistical Areas. Also, please note that the requirement for population is by MSA, not county.

  The description of other requirements such as for maintenance plans or MOUs are good information to continue to include in the plan, but was not the intent of evaluating the network requirements of 40 CFR 58 Appendix D.

- [Item 51] Minimum monitoring requirements for ozone described in 40 CFR 58 Appendix D apply only to Metropolitan Statistical Areas. Based on the population and design value, the Carson City MSA requires one ozone site. Please correct the information in your next plan to evaluate the requirement for each area separately, and indicate that there are no sites required in Micropolitan Statistical Areas. Also, please note that the requirement for population is by MSA, not county.

- [Item 60] No SO_2 monitors are required according to the plan as the PWEI is below the threshold. However, include the calculated PWEI in next year's plan.

- [Item 62] Correct the typo on the top of page 13 (Elko Site Description) for the 723 Railroad Street site from "32-007-003" to "32-007-0003".

- [Item 68] The Carson City site should make the following changes to better align with the correct terminology: change $PM_{2.5}$ "Max Concentration" to "Highest Concentration" and change O_3 "Max Concentration" to "Max O_3 Concentration

- [Item 83] Provide measurement of unrestricted airflow in degrees for the $PM_{2.5}$ monitor at Jarbidge Wilderness IMPROVE.

Additional information for each of these items may be found for the listed in column 2, in the third enclosure (*C. Annual Monitoring Network Plan Checklist)*.

C. ANNUAL MONITORING NETWORK PLAN CHECKLIST
(Updated October 1, 2015)

Year: 2015
Agency: Nevada Division of Environmental Protection

40 CFR 58.10(a)(1) requires that each Annual Network Plan (ANP) include information regarding the following types of monitors: SLAMS monitoring stations including FRM, FEM, and ARM monitors that are part of SLAMS, NCore stations, STN stations, State speciation stations, SPM stations, and/or, in serious, severe and extreme ozone nonattainment areas, PAMS stations, and SPM monitoring stations.

40 CFR 58.10(a)(1) further directs that, "The plan shall include a statement of purposes for each monitor and evidence that siting and operation of each monitor meets the requirements of appendices A, C, D, and E of this part, where applicable." On this basis, review of the ANPs is based on the requirements listed in 58.10 along with those in Appendices A, C, D, and E.

EPA Region 9 will not take action to approve or disapprove any item for which Part 58 grants approval authority to the Administrator rather than the Regional Administrators, but we will do a check to see if the required information is included and correct. The items requiring approval by the Administrator are: PAMS, NCore, and Speciation (STN/CSN).

Please note that this checklist summarizes many of the requirements of 40 CFR Part 58, but does not substitute for those requirements, nor do its contents provide a binding determination of compliance with those requirements. The checklist is subject to revision in the future and we welcome comments on its contents and structure.

Key:

White	meets the requirement
Yellow	Requirement is not met, or information is insufficient to make a determination. Action requested in next year's plan or outside the ANP process (items listed in Enclosure A).
Green	Item requires attention in order to improve next year's plan (items listed in Enclosure B).

	ANP requirement	Citation within 40 CFR 58	Was the information submitted?[1] If yes, page #s. Flag if incorrect[2]?	Does the information provided[3] meet the requirement?[4]	Notes
GENERAL PLAN REQUIREMENTS					
1.	Submit plan by July 1st	58.10 (a)(1)	Yes	Yes	Addendum for approval to discontinue CO monitor 32-005-0009-42101-1 at Stateline, NV received August 3, 2015.
2.	30-day public comment / inspection period[5]	58.10 (a)(1), 58.10 (a)(2)	Yes	Yes	NDEP did not receive any comments or questions from the public.
3.	Modifications to SLAMS network – case when we are not approving system modifications	58.10 (a)(2) 58.10 (b)(5) 58.10(e) 58.14	Yes, August 3, 2015 addendum	Insufficient to Judge	EPA will not be approving the following modifications as part of the 2015 ANP review: • Shutdown of Harvey CO SLAMS
4.	Modifications to SLAMS network – case when we are approving system modifications per 58.14	58.10 (a)(2) 58.10 (b)(5) 58.10(e) 58.14	NA	NA	
5.	Does plan include documentation (e.g., attached approval letter) for system modifications that have been approved since last ANP approval?		NA	NA	
6.	Any proposals to remove or move a monitoring station within a period of 18 months following plan submittal	58.10 (b)(5)	Yes Pg. 13-42	Yes	No proposals
7.	A plan for establishing a near-road $PM_{2.5}$ monitor (in CBSAs ≥ 2.5 million) by 1/1/2015 **(plan was due July 1, 2014)**	58.10(a)(8)(i)	NA	NA	
8.	A plan for establishing a near-road CO monitor (in CBSAs ≥ 2.5 million) by 1/1/2015 **(plan was due July 1, 2014)**	58.10(a)(7) 58.13(e)(1)	NA	NA	

[1] Response options: NA (Not Applicable), Yes, No, Incomplete, Incorrect. The responses "Incomplete" and "Incorrect" assume that some information has been provided.
[2] To the best of our knowledge.
[3] Assuming the information is correct
[4] Response options: NA (Not Applicable) – [reason], Yes, No, Insufficient to Judge.
[5] The affected state or local agency must document the process for obtaining public comment and include any comments received through the public notification process within their submitted plan.

	ANP requirement	Citation within 40 CFR 58	Was the information submitted?[1] If yes, page #s. Flag if incorrect[2]?	Does the information provided[3] meet the requirement?[4]	Notes
9.	NO_2 plan for establishment of 2nd near-road monitor by 1/1/2015 **(plan was due July 1, 2014)**	58.10 (a)(5)(iv)	NA	NA	
10.	Precision/Accuracy reports submitted to AQS	58.16(a); App A, 1.3 and 5.1.1	Yes Pg. 3	Yes	
11.	Annual data certification submitted	58.15 App. A 1.3	Yes Pg. 3	Yes	
12.	Statement that SPMs operating an FRM/FEM/ARM that meet Appendix E also meet either Appendix A or an approved alternative. Documentation for any Appendix A approved alternative should be included.[6]	58.11 (a) (2)	Yes Pg. 13-42	Yes	
13.	SPMs operating FRM/FEM/ARM monitors for over 24 months are listed as comparable to the NAAQS or the agency provided documentation that requirements from Appendices A, C, or E were not met.[7]	58.20(c)	Yes Pg. 13-42	Yes	
14.	For agencies that share monitoring responsibilities in an MSA/CSA: this agency meets full monitoring requirements or an agreement between the affected agencies and the EPA Regional Administrator is in place	App D 2(e)	NA	NA	
GENERAL PARTICULATE MONITORING REQUIREMENTS (PM_{10}, $PM_{2.5}$, Pb-TSP, Pb-PM_{10})					
15.	Designation of a primary monitor if there is more than one monitor for a pollutant at a site.	Need to determine collocation	No	Insufficient to Judge	The Carson City Armory site includes two $PM_{2.5}$ monitors, but no information is given to determine which monitor is primary.
16.	Distance between QA collocated monitors (Note: waiver request or the date of previous waiver approval must be included if the distance deviates from requirement.)	App. A 3.2.5.6 and 3.2.6.3	Yes Pg. 13-42	Yes	

[6] Alternatives to the requirements of appendix A may be approved for an SPM site as part of the approval of the annual monitoring plan, or separately.
[7] This requirement only applies to monitors that are eligible for comparison to the NAAQS per 40 CFR §§58.11(e) and 58.30.

	ANP requirement	Citation within 40 CFR 58	Was the information submitted?[1] If yes, page #s. Flag if incorrect[2]?	Does the information provided[3] meet the requirement?[4]	Notes
17.	For low volume PM instruments (flow rate < 200 liters/minute), all other PM instruments are > 1 m from the lovol. If no, list distance (meters) and instruments.	App E	Yes Pg. 13-42	Yes	
18.	For high volume PM instruments (flow rate > 200 liters/minute), all other PM instruments are > 2m from the hivol. If no, list distance (meters) and instruments.	App E	NA	NA	
$PM_{2.5}$ –SPECIFIC MONITORING REQUIREMENTS					
19.	Document how states and local agencies provide for the review of changes to a $PM_{2.5}$ monitoring network that impact the location of a violating $PM_{2.5}$ monitor.	58.10 (c)	No	Insufficient to judge	This statement is not included in the plan as required
20.	Identification of any $PM_{2.5}$ FEMs and/or ARMs not eligible to be compared to the NAAQS due to poor comparability to FRM(s) (Note 1: must include required data assessment.) (Note 2: Required SLAMS must monitor $PM_{2.5}$ with NAAQS-comparable monitor at the required sample frequency.)	58.10 (b)(13) 58.11 (e)	NA	NA	

	ANP requirement	Citation within 40 CFR 58	Was the information submitted?[1] If yes, page #s. Flag if incorrect[2]?	Does the information provided[3] meet the requirement?[4]	Notes
21.	Minimum # of monitoring **sites** for $PM_{2.5}$ [Note 1: should be supported by MSA ID, MSA population, DV, # monitoring sites, and # required monitoring sites] [Note 2: Only monitors considered to be required SLAMs are eligible to be counted towards meeting minimum monitoring requirements.]	App D, 4.7.1(a) and Table D-5	Yes Pg. 8	Yes	Minimum monitoring requirements for $PM_{2.5}$ only apply to Metropolitan Statistical Areas. Since Gardnerville Ranchos is a Micropolitan Statistical Area, there are no monitors currently required for this area by 40 CFR 58 Appendix D. Also, as a general note, SPMs do not count towards meeting minimum monitoring requirements. Also, please note that the requirement for population is by MSA, not county. The minimum monitoring requirements for $PM_{2.5}$ are specified in 40 CFR 58 Appendix D 4.7.1(a): "State, and where applicable local, agencies must operate the minimum number of required $PM_{2.5}$ SLAMS sites listed in Table D-5 of this appendix." Please correct Table 2 to reflect the number of SLAMS sites, rather than monitors. According to information provided in the site tables, Table 2 should indicate that there is 1 active site in the Carson MSA and either remove the row for Gardnerville Ranchos or list 0 active sites, as the only monitor is not a SLAMS, but an SPM.
22.	Requirements for continuous $PM_{2.5}$ monitoring (number of monitors and collocation)	App D 4.7.2	Yes Pg. 22	Yes	Since there are 0-1 $PM_{2.5}$ SLAMS sites required for the Carson City MSA, 40 CFR Appendix D 4.7.2 requires 0-1 continuous monitor in the MSA.
23.	FRM/FEM/ARM $PM_{2.5}$ QA collocation	App A 3.2.5	Incomplete Pg. 13-42	Insufficient to Judge	This requirement cannot be judged since the plan does not specify which monitor is primary at Carson City Armory site. Please update this in ANP under "Detailed Site Information".
24.	$PM_{2.5}$ Chemical Speciation requirements for official STN sites	App D 4.7.4	NA	NA	
25.	Identification of sites suitable and sites not suitable for comparison to the annual $PM_{2.5}$ NAAQS as described in Part 58.30	58.10 (b)(7)	Yes Pg. 13-42	Yes	There is a row in the site called "suitable for $PM_{2.5}$ comparison", though this is likely the row asking for "suitable for annual $PM_{2.5}$ comparison". Please correct in future plans.
26.	Required $PM_{2.5}$ sites represent area-wide air quality	App D 4.7.1(b)	Yes Pg. 13-42	Yes	

	ANP requirement	Citation within 40 CFR 58	Was the information submitted?[1] If yes, page #s. Flag if incorrect[2]?	Does the information provided[3] meet the requirement?[4]	Notes
27.	For $PM_{2.5}$, within each MSA, at least one site at neighborhood or larger scale in an area of expected maximum concentration	App D 4.7.1(b)(1)	Yes Pg. 13-42	Yes	
28.	Minimum monitoring requirement for near-road $PM_{2.5}$ monitor (in CBSA $\geq$ 2.5 million) by 1/1/2015	58.13(f)(1) App D 4.7.1(b)(2)	NA	NA	
29.	If additional SLAMS $PM_{2.5}$ is required, there is a site in an area of poor air quality	App D 4.7.1(b)(3)	NA	NA	
30.	States must have at least one $PM_{2.5}$ regional background and one $PM_{2.5}$ regional transport site.	App D 4.7.3	Yes Pg. 13-42	Yes	The IMPROVE site at Jarbidge Wilderness fulfills this requirement.
31.	Sampling schedule for $PM_{2.5}$ - applies to year-round and seasonal sampling schedules (note: date of waiver approval must be included if the sampling season deviates from requirement)	58.10 (b)(4) 58.12(d) App D 4.7 EPA flowchart	Incomplete	Insufficient to judge	Without the primary monitor specified at Carson City Armory, this requirement cannot be determined.
32.	Frequency of flow rate verification for manual $PM_{2.5}$ monitors audit	App A 3.3.2	Yes Pg. 13-42	Yes	
33.	Frequency of flow rate verification for automated $PM_{2.5}$ monitors audit	App A 3.2.3	Yes Pg. 13-42	Yes	
34.	Dates of two semi-annual flow rate audits conducted in **CY2014** for $PM_{2.5}$ monitors	App A, 3.2.4 and 3.3.3	Yes Pg. 13-42	Yes	

PM_{10} –SPECIFIC MONITORING REQUIREMENTS					
35.	Minimum # of monitoring sites for PM_{10}	App D, 4.6 (a) and Table D-4	Yes Pg. 8	Yes	The information provided in your plan for the required number of monitoring sites required by 40 CFR 58 Appendix D is incorrect. The population threshold for MSAs requiring PM_{10} monitoring is 100,000. In your next plan, please note that there are no requirements per 40 CFR 58 Appendix D for PM_{10} monitoring in the Carson City MSA and also none required in Micropolitan Statistical Areas, such as Elko and Pahrump. Please correct the information in your next plan to evaluate the requirement for each area separately, and indicate that there are no sites required in Micropolitan Statistical Areas. Also, please note that the requirement for population is by MSA, not county. The description of other requirements such as for maintenance plans or MOUs are good information to continue to include in the plan, but was not the intent of evaluating the network requirements of 40 CFR 58 Appendix D.
36.	Manual PM_{10} method collocation (note: continuous PM_{10} does not have this requirement)	App A 3.3.1	NA	NA	No manual PM_{10} methods
37.	Sampling schedule for PM_{10}	58.10 (b)(4) 58.12(e) App D 4.6	Yes Pg. 13-42	Yes	
38.	Frequency of flow rate verification for manual PM_{10} monitors audit	App A 3.3.2	Yes Pg. 13-42	Yes	
39.	Frequency of flow rate verification for automated PM_{10} monitors audit	App A 3.2.3	Yes Pg. 13-42	Yes	
40.	Dates of two semi-annual flow rate audits conducted in **CY2014** for PM_{10} monitors	App A, 3.2.4 and 3.3.3	Yes Pg. 13-42	Yes	
Pb –SPECIFIC MONITORING REQUIREMENTS					
41.	Minimum # of monitors for non-NCore Pb [Note: Only monitors considered to be required SLAMs are eligible to be counted towards meeting minimum monitoring requirements.]	App D 4.5 58.13(a)	Yes Pg. 6	Yes	No requirement
42.	Pb collocation: for non-NCore sites	App A 3.3.4.3	NA	NA	
43.	Any source-oriented Pb site for which a waiver has been granted by EPA Regional Administrator	58.10 (b)(10)	NA	NA	

44.	Any Pb monitor for which a waiver has been requested or granted by EPA Regional Administrator for use of Pb-PM_{10} in lieu of Pb-TSP	58.10 (b)(11)	NA	NA	
45.	Designation of any Pb monitors as either source-oriented or non-source-oriented	58.10 (b)(9)	NA	NA	
46.	Sampling schedule for Pb	58.10 (b)(4) 58.12(b) App D 4.5	NA	NA	
47.	Frequency of flow rate verification for Pb monitors audit	App A 3.3.4.1	NA	NA	
48.	Dates of two semi-annual flow rate audits conducted in **CY2014** for Pb monitors	App A 3.3.4.1	NA	NA	
GENERAL GASEOUS MONITORING REQUIREMENTS					
49.	Frequency of one-point QC check (gaseous)	App. A 3.2.1	Yes Pg. 13-42	Yes	
50.	Date of Annual Performance Evaluation (gaseous) conducted in **CY2014**	App. A 3.2.2	Yes Pg. 13-42	Yes	
O_3 –SPECIFIC MONITORING REQUIREMENTS					
51.	Minimum # of monitoring sites for O_3 [Note: should be supported by MSA ID, MSA population, DV, # monitoring sites, and # required monitoring sites][8]	App D, 4.1(a) and Table D-2	Yes Pg. 8	Yes	Minimum monitoring requirements for ozone described in 40 CFR 58 Appendix D apply only to Metropolitan Statistical Areas. Based on the population and design value, the Carson City MSA requires one ozone site. Please correct the information in your next plan to evaluate the requirement for each area separately, and indicate that there are no sites required in Micropolitan Statistical Areas. Also, please note that the requirement for population is by MSA, not county.
52.	Identification of maximum concentration O_3 site(s)	App D 4.1 (b)	Yes Pg. 13-42	Yes	
53.	Sampling season for O_3 (Note: Waivers must be renewed annually. EPA expects agencies to submit re-evaluations of the relevant data each year with the ANP. EPA will then respond as part of the ANP response.)	58.10 (b)(4) App D, 4.1(i)	Yes Pg. 9, 13-42	Yes	All ozone monitors switched to year-round monitoring starting April 1, 2015

[8] Only monitors considered to be required SLAMs are eligible to be counted towards meeting minimum monitoring requirements. In addition, ozone monitors that do not meet traffic count/distance requirements to be neighborhood or urban scale (40 CFR 58 Appendix E, Table E-1) cannot be counted towards minimum monitoring requirements.

NO_2 –SPECIFIC MONITORING REQUIREMENTS					
54.	Minimum monitoring requirement for single near-road NO_2 monitor (in CBSA ≥ 1 million) by 1/1/2014	58.13(c)(3) App D 4.3.2	NA	NA	
55.	Minimum monitoring requirement for second near-road NO_2 monitor (in CBSA ≥ 2.5 million) by 1/1/2015	58.13(c)(4) App D 4.3.2	NA	NA	
56.	Minimum monitoring requirements for area-wide NO_2 monitor in location of expected highest NO_2 concentrations representing neighborhood or larger scale (operation required by January 1, 2013)	App D 4.3.3	NA	NA	
57.	Minimum monitoring requirements for susceptible and vulnerable populations monitoring (aka RA40) NO_2 (operation required by January 1, 2013)	App D 4.3.4	NA	NA	
58.	Identification of required NO_2 monitors as either near-road, area-wide, or vulnerable and susceptible population (aka RA40)	58.10 (b)(12)	NA	NA	
CO –SPECIFIC MONITORING REQUIREMENTS					
59.	Minimum monitoring requirement for near-road CO monitor (in CBSA ≥ 2.5 million) by 1/1/2015	58.13(e)(1) App D 4.2.1	NA	NA	
SO_2 –SPECIFIC MONITORING REQUIREMENTS					
60.	Minimum monitoring requirements for SO_2 [Note: Only monitors considered to be required SLAMs are eligible to be counted towards meeting minimum monitoring requirements.]	App D 4.4	Yes Pg. 6, 8	Yes	No monitors are required according to the plan as the PWEI is below the threshold. However, include the calculated PWEI in next year's plan.

NCORE –SPECIFIC MONITORING REQUIREMENTS					
61.	NCore site and all required parameters operational: year-round O_3, trace SO_2, trace CO, NO_y, NO, $PM_{2.5}$ mass, $PM_{2.5}$ continuous, $PM_{2.5}$ speciation, $PM_{10-2.5}$ mass, resultant wind speed at 10m, resultant wind direction at 10m, ambient temperature, relative humidity, and Pb at CBSAs ≥ 500,000.	58.10 (a)(3); Pb collocation App. A 3.3.4.3; $PM_{10-2.5}$ minimum monitoring App. D 4.8; $PM_{10-2.5}$ sampling schedule 58.10 (b)(4) 58.12(f) App D 4.8; $PM_{10-2.5}$ collocation App. A 3.3.6	NA	NA	
SITE OR MONITOR - SPECIFIC REQUIREMENTS (OFTEN INCLUDED IN DETAILED SITE INFORMATION TABLES)					
62.	AQS site identification number for each site	58.10 (b)(1)	Yes Pg. 13-42	Yes	Correct typo on the top of page 13 (Elko Site Description) for the 723 Railroad Street site from "32-007-003" to "32-007-0003".
63.	Location of each site: street address and geographic coordinates	58.10 (b)(2)	Yes Pg. 13-42	Yes	Add Jarbidge monitoring location to map.
64.	MSA, CBSA, CSA or other area represented by the monitor	58.10 (b)(8)	Yes Pg. 13-42	Yes	
65.	Parameter occurrence code for each monitor	Needed to determine if other requirements (e.g., min # and collocation) are met	Yes Pg. 13-42	Yes	
66.	Statement of purpose for each monitor	58.10 (a)(1)	Yes Pg. 3-4, 13-42	Yes	The statement of purpose for the $PM_{2.5}$ monitor at Jarbidge is stated on pages 3-4, but this information would be useful if also provided in the site table.

67.	Basic monitoring objective for each monitor	App D 1.1 58.10 (b)(6)	Yes Pg. 13-42	Incorrect in one instance	The basic monitoring objective for the $PM_{2.5}$ monitor at Jarbidge Wilderness IMPROVE is "Other", which is not an applicable monitoring objective. Appropriate monitoring objectives are: (a) Provide air pollution data to public in a timely manner (b) NAAQS comparison (c) Research support
68.	Site type for each monitor	App D 1.1.1	Yes Pg. 13-42	Yes	The Carson City site should make the following changes to better align with the correct terminology: • $PM_{2.5.}$ – Change "Max Concentration" to "Highest Concentration" • O_3 – Change "Max Concentration" to "Max O_3 Concentration
69.	Monitor type for each monitor, and Network Affiliation(s) as appropriate	Needed to determine if other requirements (e.g., min # and collocation) are met	Yes Pg. 13-42	Incorrect in one stance	IMPROVE is not a monitor type, but is the Network Affiliation for the $PM_{2.5}$ Jarbidge monitor. Appropriate monitor types are: • SLAMS • Special Purpose • Industrial • Non-EPA Federal • Tribal • EPA • Other
70.	Scale of representativeness for each monitor as defined in Appendix D	58.10(b)(6); App D	Yes Pg. 13-42	Incorrect in one instance	The Linda Street PM_{10} monitor is listed as an Urban scale site, however, the distance to roadway and AADT do not meeting the criteria for Urban scale (20m, 22,000 AADT)
71.	Parameter code for each monitor	Needed to determine if other requirements (e.g., min # and collocation) are met	Yes Pg. 13-42	Incorrect in one instance	The $PM_{2.5}$ monitor at Jarbidge is listed as a non-FRM/FEM/ARM (IMPROVE Sampler Version II). If this information is correct, then the parameter code for $PM_{2.5}$ at this site should not be 88501, not 88101.
72.	Method code and description (e.g., manufacturer & model) for each monitor	58.10 (b)(3); App C 2.4.1.2	Yes Pg. 13-42	Yes	

73.	Sampling start date for each monitor	Needed to determine if other requirements (e.g., min # and collocation) are met	Yes Pg. 13-42	Yes	
74.	Distance of monitor from nearest road	App E 6	Yes Pg. 13-42	No	Distance to roadway and AADT do not match the spatial scale for Linda Street PM_{10} (Urban scale, 20m to road, 22,000 AADT).
75.	Traffic count of nearest road	App E	Yes Pg. 13-42	No	Distance to roadway and AADT do not match the spatial scale for Linda Street PM_{10} (Urban scale, 20m to road, 22,000 AADT). The traffic count for Jarbidge Wilderness IMPROVE $PM_{2.5}$ monitor is listed as "NA". Please clarify if that is intending to state that it is negligible.
76.	Groundcover	App E 3(a)	Yes Pg. 13-42	Yes	
77.	Probe height	App E 2	Yes Pg. 13-42	Yes	
78.	Distance from supporting structure	App E 2	Yes Pg. 13-42	Insufficient to judge	The following monitors may not be meeting the requirement: • Elko – PM_{10} (1.2m) • Carson City Armory – $PM_{2.5}$ (1.5m, 1.5m) • Manse Elementary – PM_{10} (>1m) • Glen Oaks – PM_{10} (>1m)
79.	Distance from obstructions on roof (horizontal distance to the obstruction and vertical height of the obstruction above the probe should be provided)	App E 4(b)	Yes Pg. 13-42	Yes	
80.	Distance from obstructions not on roof (horizontal distance to the obstruction and vertical height of the obstruction above the probe should be provided)	App E 4(a)	Incomplete Pg. 13-42	Insufficient to judge	Provide vertical heights of obstructions above the probe (and tree height above the probe as trees can act as obstructions) at all sites.
81.	Distance from the drip line of closest tree(s)	App E 5	Yes Pg. 13-42	Yes	
82.	Distance to furnace or incinerator flue	App E 3(b)	Yes Pg. 13-42	Yes	
83.	Unrestricted airflow (expressed as degrees around probe/inlet or percentage of monitoring path)	App E, 4(a) and 4(b)	Yes Pg. 13-42	Yes	In next year's ANP, please provide measurement of unrestricted airflow in degrees for the $PM_{2.5}$ monitor at Jarbidge Wilderness IMPROVE
84.	Probe material ($NO/NO_2/NO_y$, SO_2, O_3; For PAMS: VOCs, Carbonyls)	App E 9	Yes Pg. 13-42	Yes	

85.	Residence time ($NO/NO_2/NO_y$, SO_2, O_3; For PAMS: VOCs, Carbonyls)	App E 9	Yes Pg. 13-42	Yes	

Public Comments on Annual Network Plan
Were comments submitted to the S/L/T agency during the public comment period?

No

If no, skip the remaining questions.
If yes:

- Were any of the comments substantive?
  - If yes, which ones?
  - Explain basis for determination if any comments were considered not substantive:
- Did the agency respond to the substantive comments? Yes
  - If yes, was the response adequate?
- Do the substantive comments require separate EPA response (i.e., agency response wasn't adequate)?

APPENDIX B
NPS 2015 Data Certification Letter

United States Department of the Interior

NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, Colorado 80225

April 27, 2016

Mr. Lew Weinstock
U.S. Environmental Protection Agency
Research Triangle Park, NC 27709
Room C304-02
Re: Certification of National Park Service, Gaseous Pollutant Monitoring Program Data for 2015

Dear Mr. Weinstock,

The National Park Service, Air Resources Division, hereby certifies the NPS Gaseous Pollutant Monitoring Program (GPMP) ozone data for the year 2015 that currently reside on the EPA AQS. The ambient concentration data and associated quality assurance data have been completely submitted to AQS for the year 2015. These data have undergone stringent validation procedures and are believed to be a consistent and accurate representation of ambient air quality conditions within the monitored NPS units. All quality assurance findings have been taken into account in determining the data's validity.

Attached are:

- A summary table of NPS units that the NPS intends to certify for 2015.
- AMP600 Data Certification Report for 2015 data.

Please refer to the attached summary table that lists which sites the NPS intends to certify. There are sites operated by the NPS that we do not wish to certify because of the method used or because the site does not belong solely to the NPS. These sites are not included in the table. Please contact me (barkley_sive@nps.gov; 303-987-6947) if you have any questions.

Sincerely,

Barkley Sive
Program Manager

BS:jw

Cc: John Vimont
Kristi Morris

National Park Service
Gaseous Pollutant Monitoring Program
Data Certification for
Calendar Year 2015
List of Sites

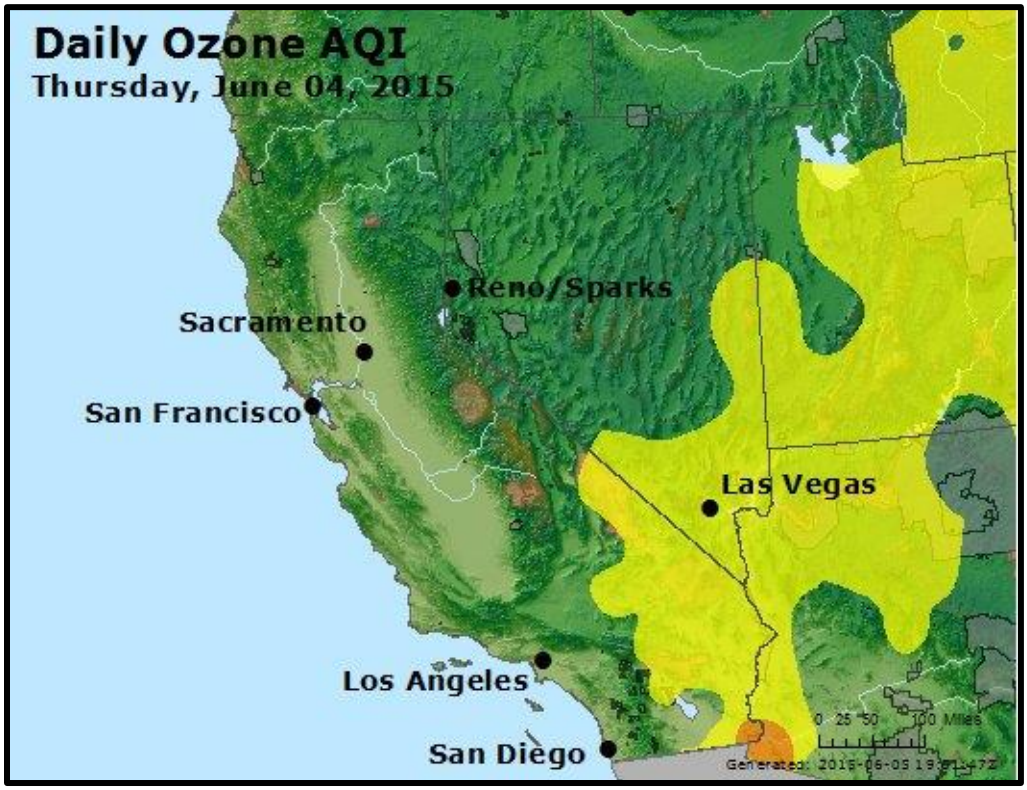
State	AQS Number	Site(s)
Alaska	02-068-0003	Denali National Park
Arizona	04-003-8001	Chiricahua National Monument
	04-005-8001	Grand Canyon National Park
	04-017-0119	Petrified Forest National Park
California	06-027-0101	Death Valley National Park
		Joshua Tree National Park
	06-071-9002	Black Rock
	06-089-3003	Lassen Volcanic National Park
	06-069-0003	Pinnacles National Monument
		Sequoia National Park
	06-107-0009	Ash Mountain
	06-107-0006	Lower Kaweah
	06-043-0003	Yosemite National Park
Colorado	08-083-0101	Mesa Verde National Park
	08-069-0007	Rocky Mountain National Park
Idaho	16-023-0101	Craters of the Moon National Monument
Kentucky	21-061-0501	Mammoth Cave National Park
Minnesota	27-137-0034	Voyageurs National Park
Montana	30-029-8001	Glacier National Park
Nevada	32-033-0101	Great Basin National Park
Tennessee		Great Smoky Mountains National Park
	47-155-0102	Clingmans Dome
	47-155-0101	Cove Mountain
	47-009-0101	Look Rock
Texas	48-043-0101	Big Bend National Park
Utah	49-037-0101	Canyonlands National Park
	49-047-1002	Dinosaur National Monument
	49-053-0130	Zion National Park
Virginia	51-113-0003	Shenandoah National Park
Wyoming	56-039-0008	Grand Teton National Park
		Yellowstone National Park
	56-039-1011	Water Tank
	56-039-1013	Old Faithful Snow Lodge

Data for the sites listed above are directly collected, validated, and reported by the NPS ARD. Only data from these sites are certified by the NPS. Several state agencies also monitor ambient air quality in selected national parks. These agencies are directly and independently responsible for their data and its submission to AQS.

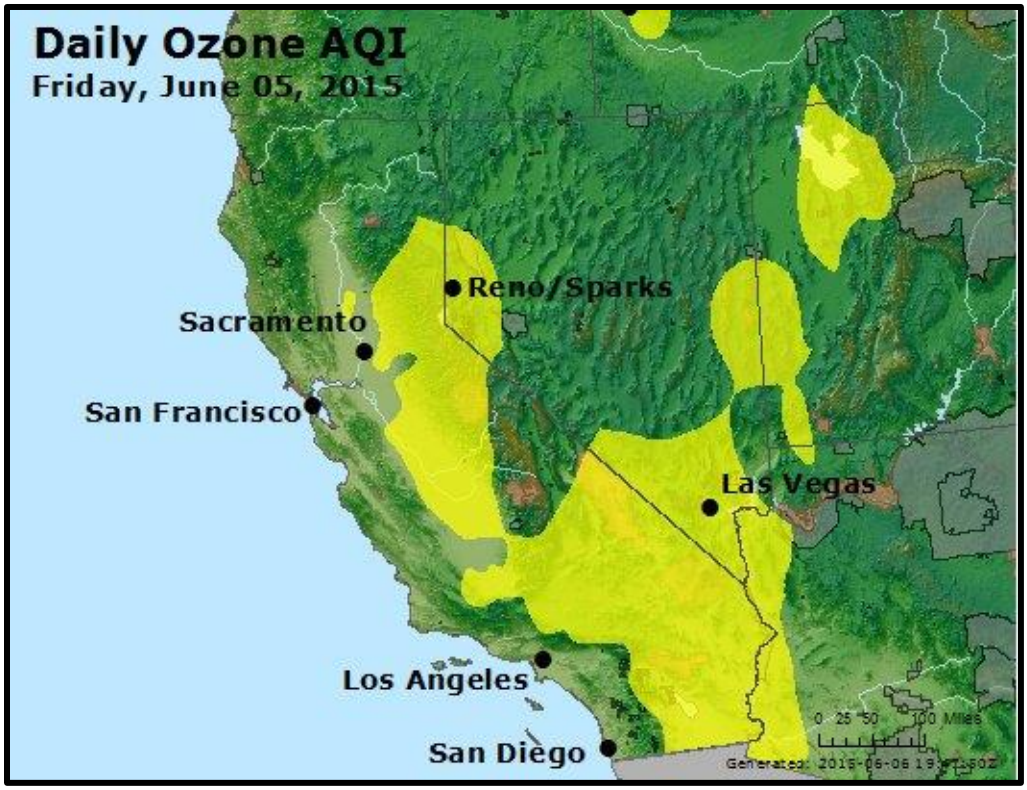
APPENDIX C

AQI Values for the Western United States June 3 through 10, 2015

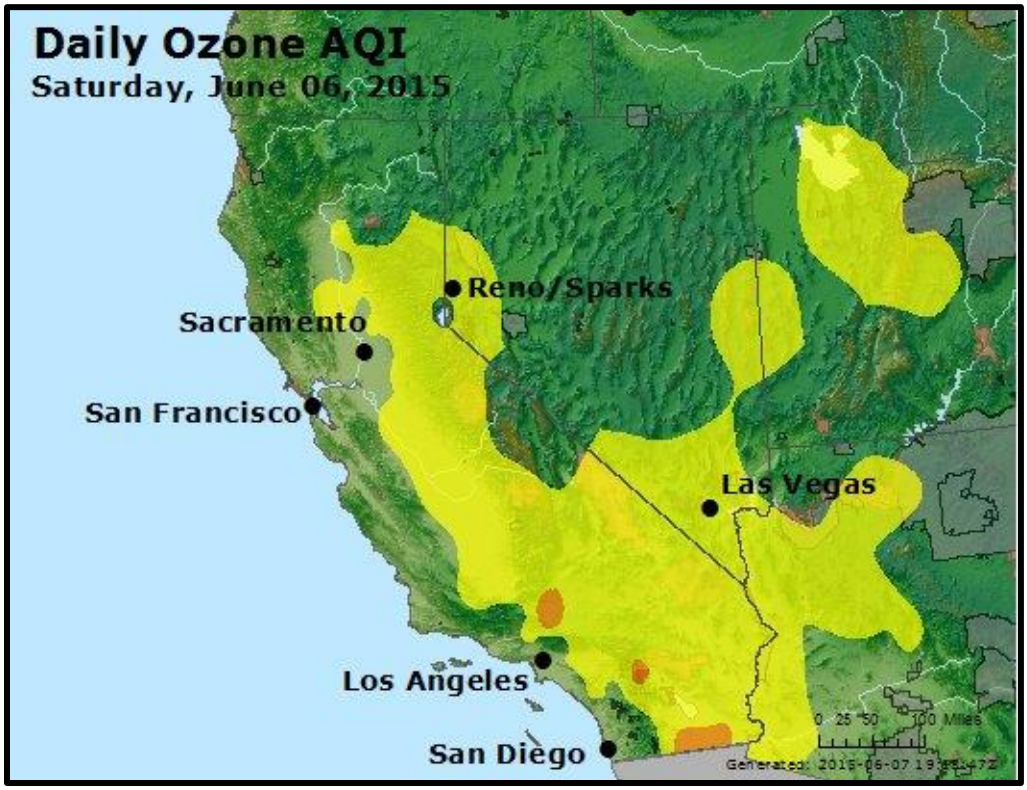
AQI Values for the western United States on June 3, 2015.



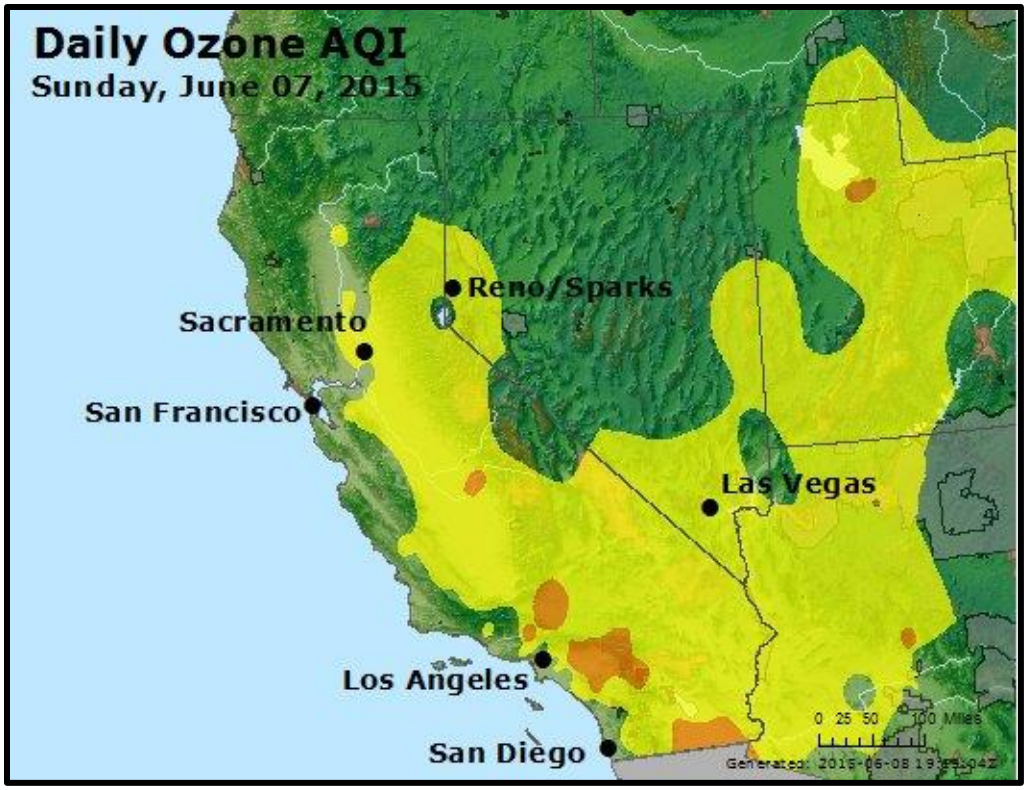
AQI Values for the western United States on June 4, 2015.



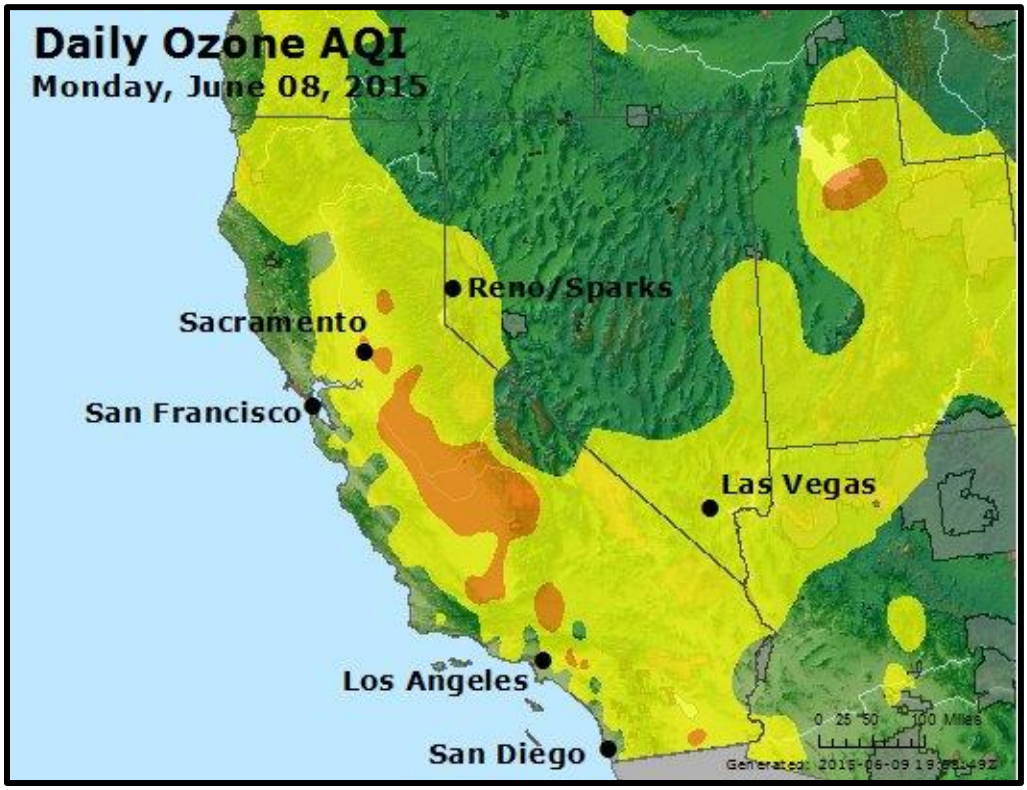
AQI Values for the western United States on June 5, 2015.



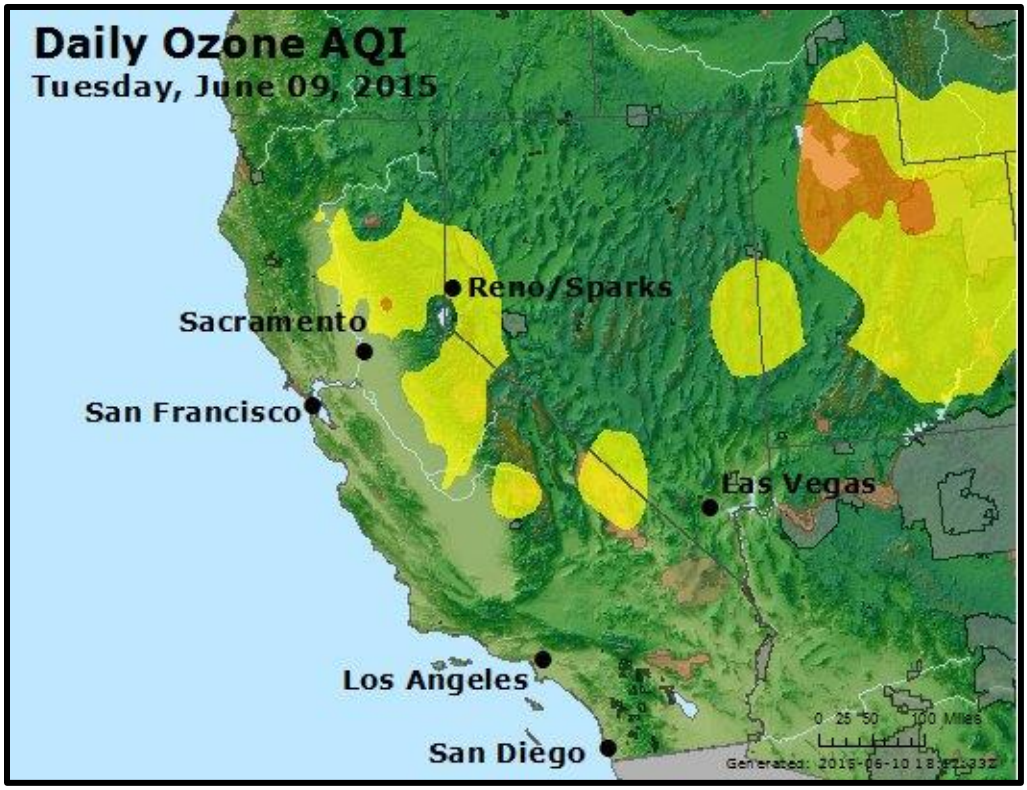
AQI Values for the western United States on June 6, 2015.



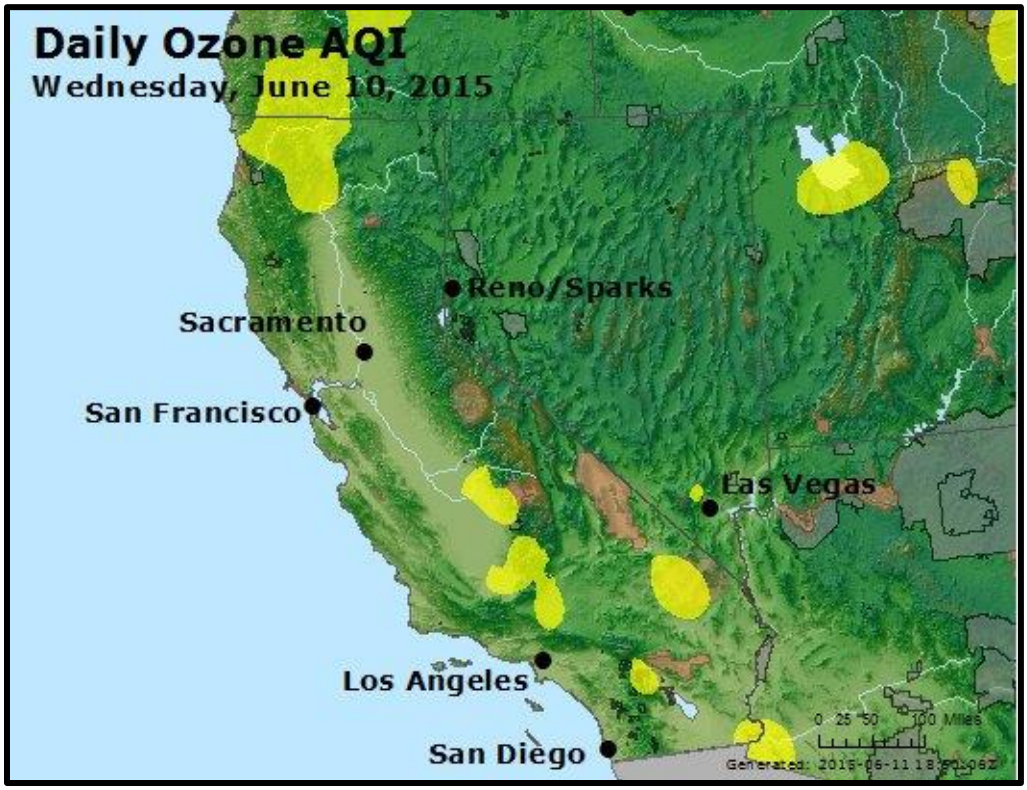
AQI Values for the western United States on June 7, 2015.



AQI Values for the western United States on June 8, 2015.



AQI Values for the western United States on June 9, 2015.



AQI Values for the western United States on June 10, 2015.

APPENDIX D
ARS CASTNET Audit Results

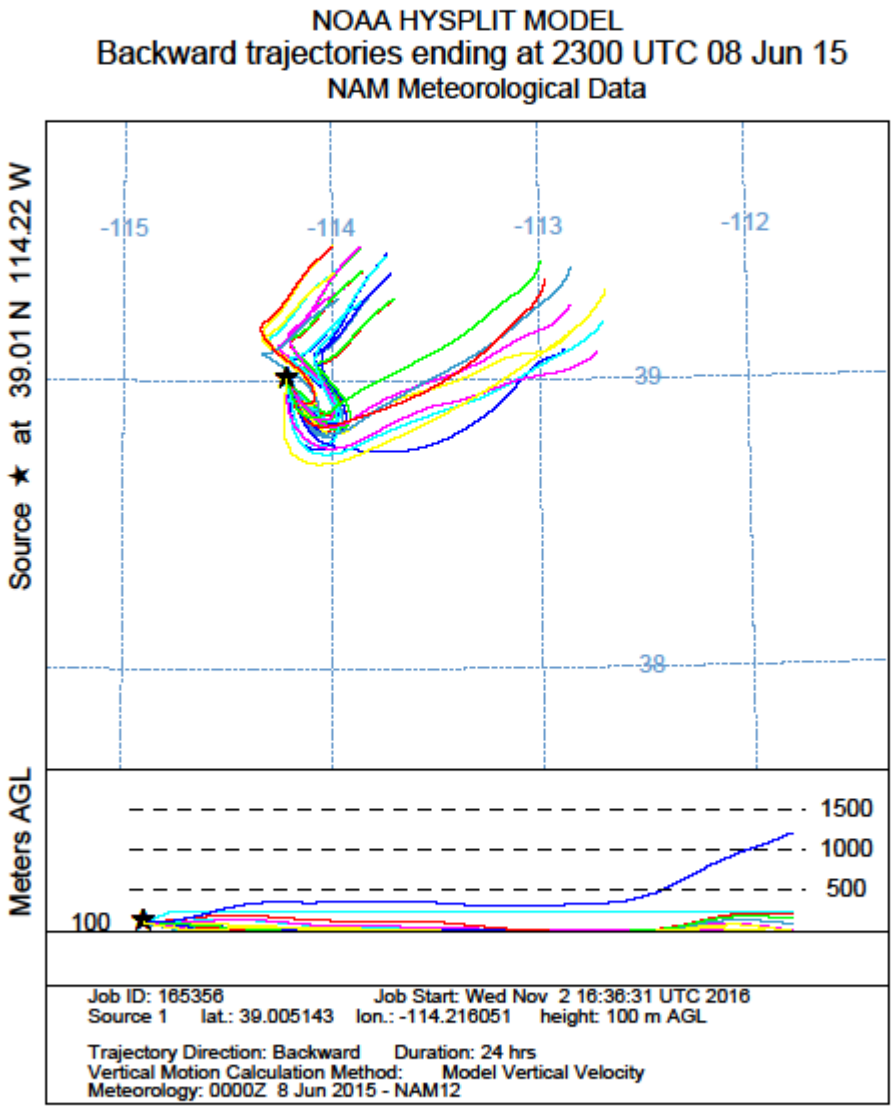
EEMS Spot Report

Data Compiled: 1/13/2016 6:58:13 PM

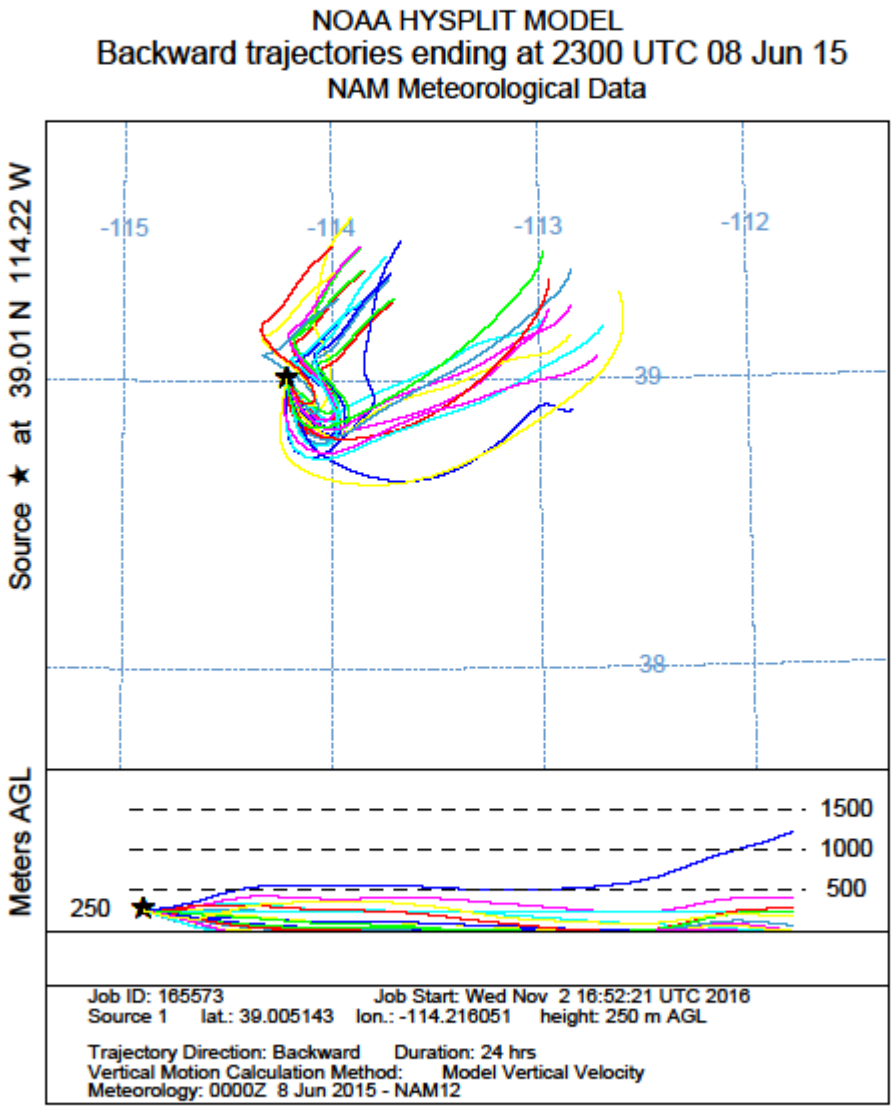
SiteVisitDate	Site	Technician
05/08/2015	GRB411	Alison Ray

Line	Audited Parameter	DAS	Ch. #	Criteria +/-	Counts	QaResult	Units	Pass/Fail
1	Ozone Slope	P	0	1.1	4	0.94442	unitless	**P**
2	Ozone Intercept	P	0	5	4	-0.27184	ppb	**P**
3	Ozone correlation	P	0	0.995	4	0.99997	unitless	**P**
4	Ozone % difference avg	P	7	10	4	5.9	%	**P**
5	Ozone % difference max	P	7	10	4	6.3	%	**P**

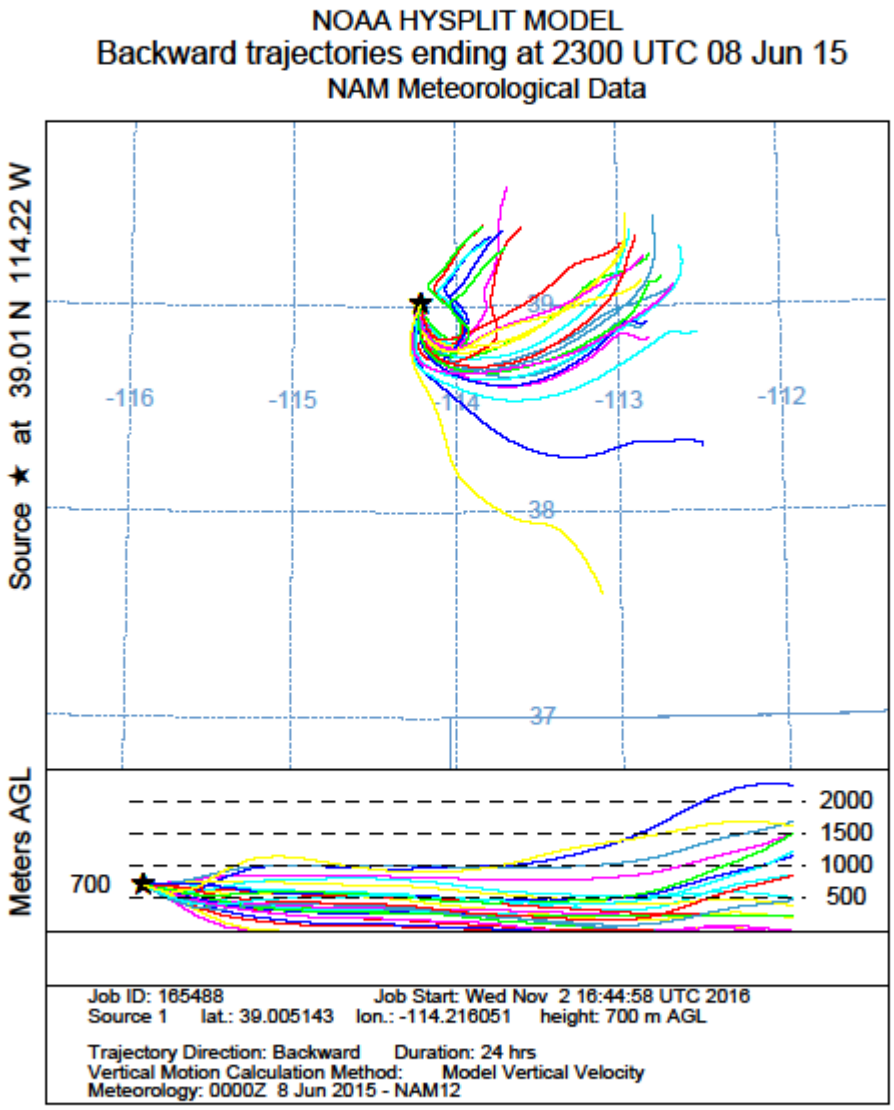
APPENDIX E
HYSPLIT Backward Trajectories



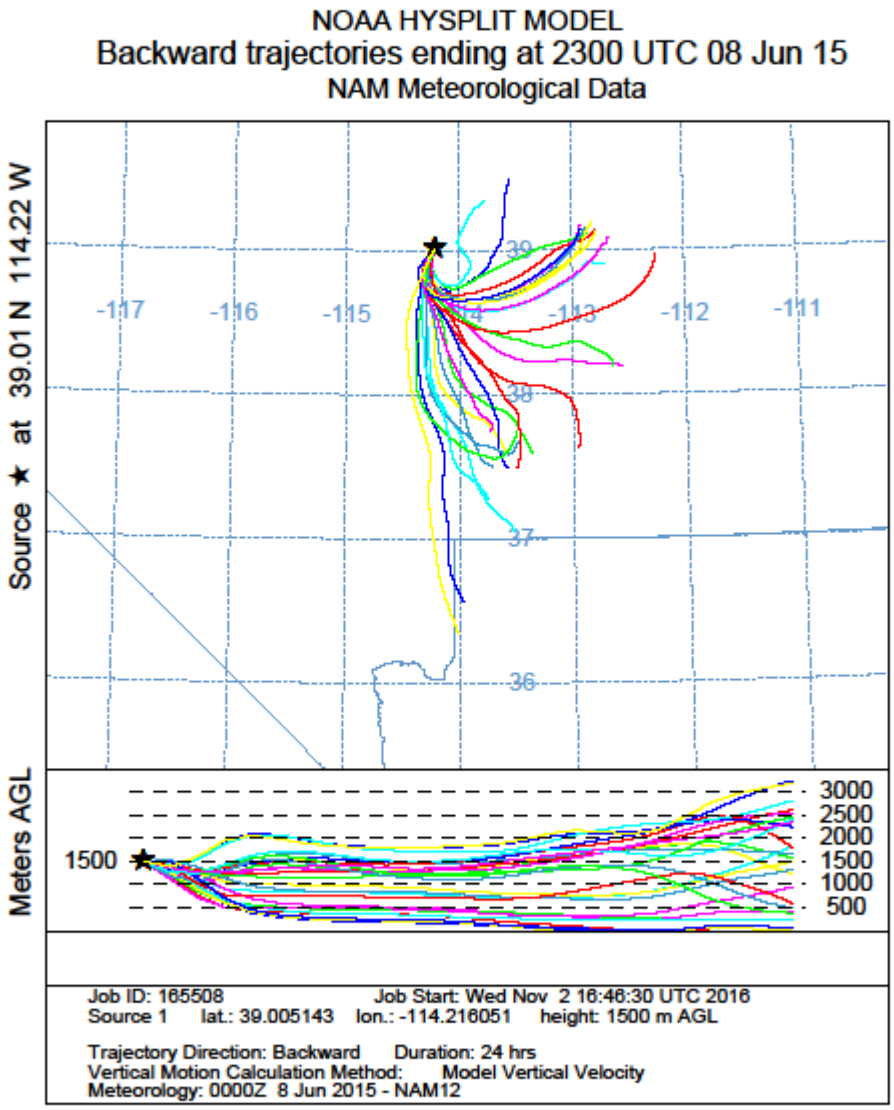
24-hour backward trajectory from Great Basin National Park (GBNP), Nevada, initiated at 2300 UTC (1500 PST) June 8, 2015 from 100 m above ground level (agl).



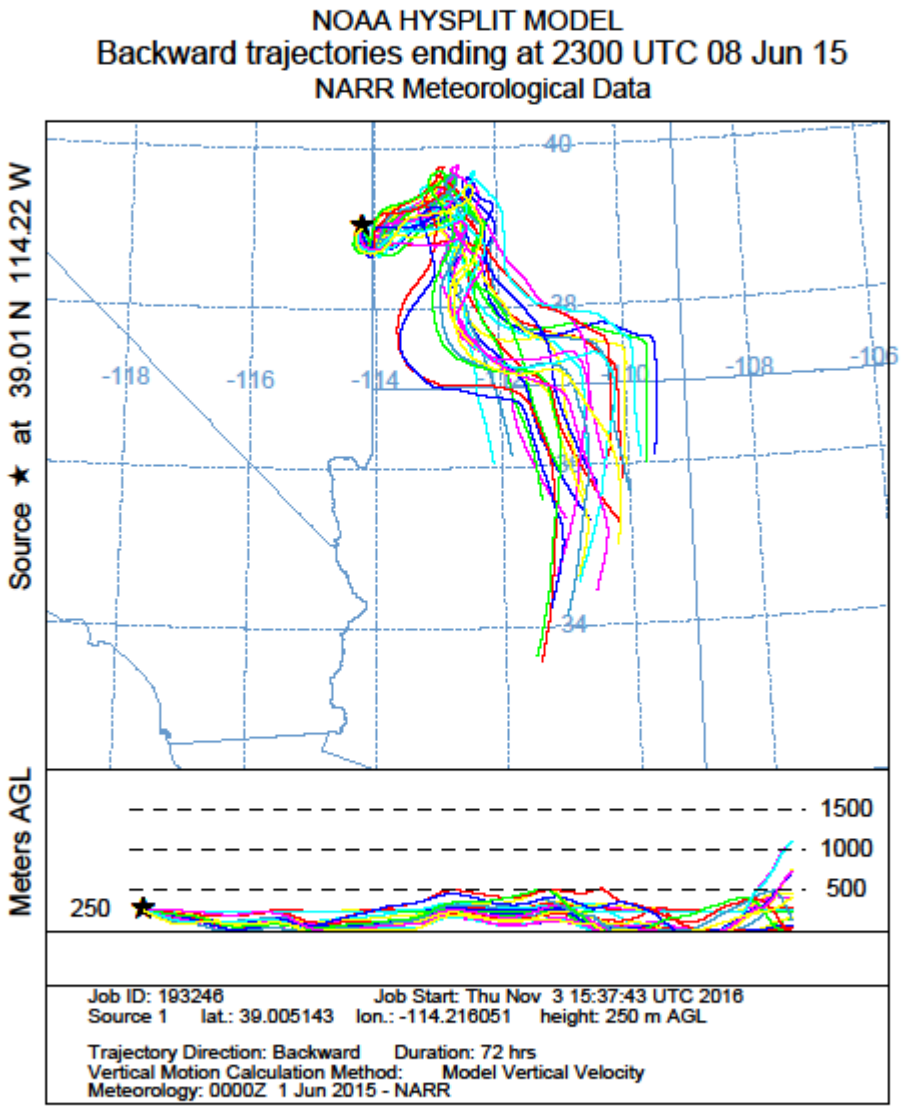
24-hour backward trajectory from GBNP, Nevada, initiated at 2300 UTC (1500 PST) June 8, 2015 from 250 m agl.



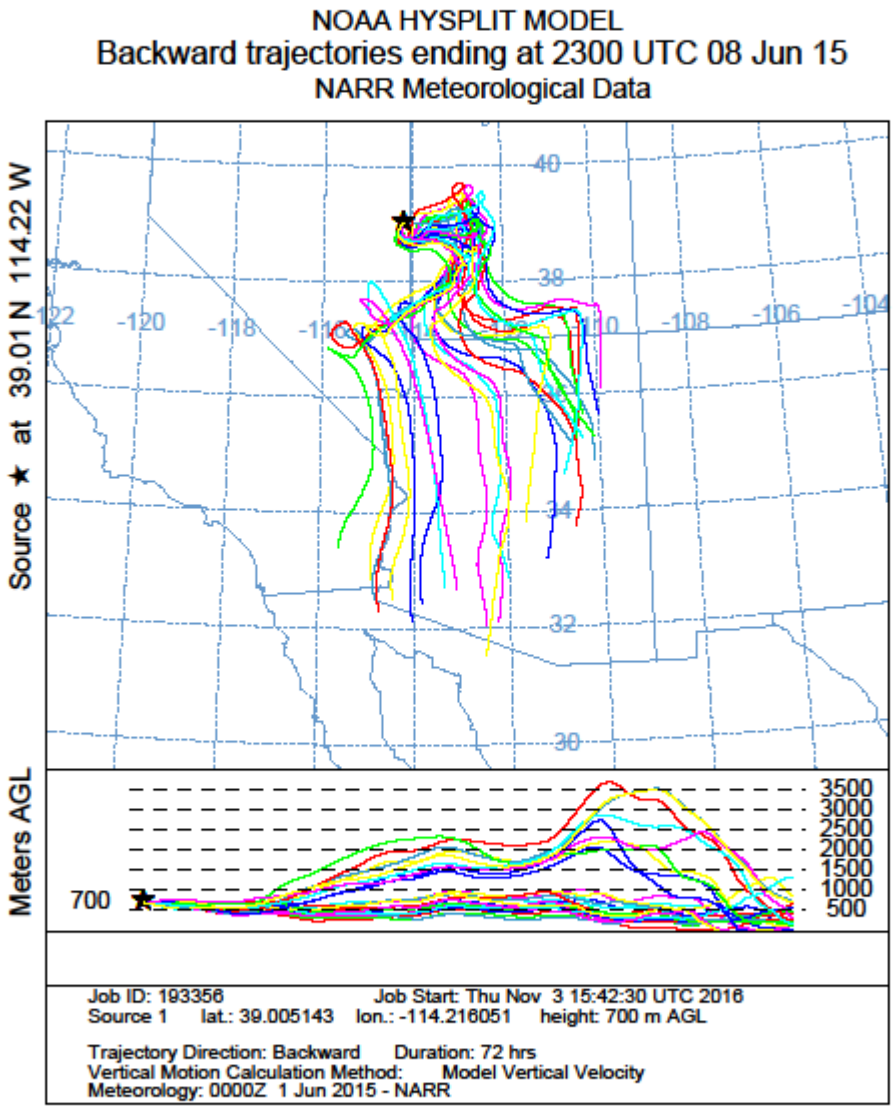
24-hour backward trajectory from GBNP, Nevada, initiated at 2300 UTC (1500 PST) June 8, 2015 from 700 m agl.



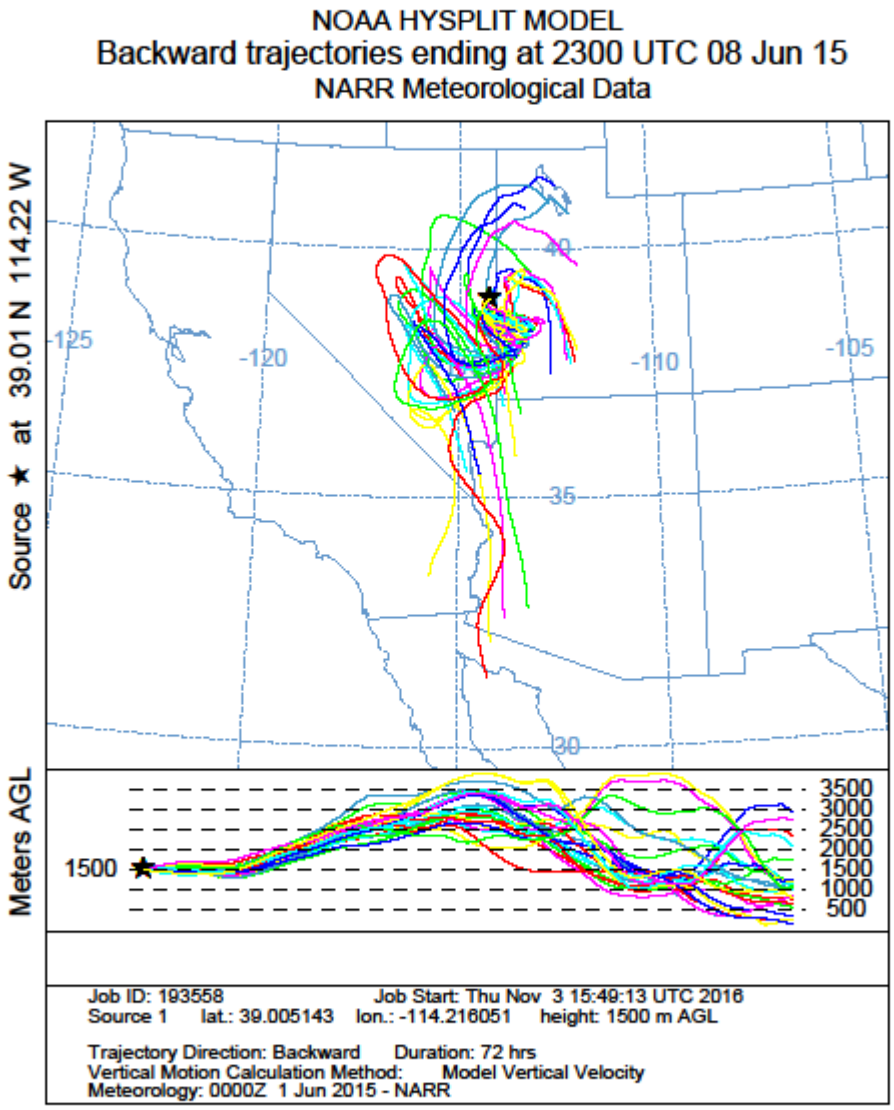
24-hour backward trajectory from GBNP, Nevada, initiated at 2300 UTC (1500 PST) June 8, 2015 from 1500 m agl.



72-hour backward trajectory from GBNP, Nevada, initiated at 2300 UTC (1500 PST) June 8, 2015 from 250 m agl.



72-hour backward trajectory from GBNP, Nevada, initiated at 2300 UTC (1500 PST) June 8, 2015 from 700 m agl.



72-hour backward trajectory from GBNP, Nevada, initiated at 2300 UTC (1500 PST) June 8, 2015 from 1,500 m agl.